MECHANICAL ENGINEERING

· OCTOBER 1948 ·

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OCT -5 1948

Loafing Btu's produce no power

Bailey Control on two 65,000 lb. per hour boilers at White Motor Co., Cleveland, Ohio. Day to day evaporation runs consistently above the guarantee.

You find loafers everywhere. Even in a collection of Btu's. You have to *make* them work if you expect to get low cost power. And that is exactly what the Bailey co-ordinated boiler control system is designed to do.

It reduces fuel consumption per pound of steam generated. Combustion, feed water, steam temperature, heater levels, pump speeds and other factors are co-ordinated. Safety of operation is increased—continuity of service is improved. You convert the maximum number of Btu's into power and get all the efficiency your boiler was designed to deliver.

One thing to remember, however, is the fact that this Bailey system is not delivered in a standard package. Each one is designed and engineered to the specific job on which it is to be used. That's *why* it functions so efficiently.

If you are looking for low cost power, it will pay you to call our nearest office.

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MECHANICAL ENGINEERING, October, 1948, Vol. 70, No. 10. Published monthly by The American Society of Mechanical Engineers, at 20th and Northampton Sts., Easton, Pa. Editorial and Advertising departments, 29 West 39th St., New York 18, N. Y. Price 75¢ a copy, $7.00 a year; to members and affiliates, 50¢ a copy, $4.00 a year. Postage to Canada, 75¢ additional, to foreign countries $1.50 additional. Entered as second-class matter December 21, 1920, at the Post Office at Easton, Pa., under the act of March 3, 1879. Member of the Audit Bureau of Circulations.

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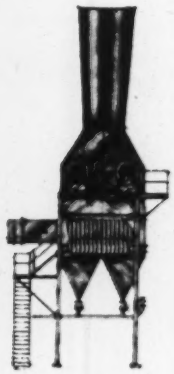

The Secret of CONTROL

Thermix Fan Stacks produce a definite controlled degree of draft—because in a unit packaged design they combine, (1) the induced draft fan, (2) the breeching connecting the fan and stack and (3) the stack itself. All *three* are interdependent and affect the controlled, overall operation. To design, engineer and purchase these parts separately would not produce the same accurate, known results that this packaged unit offers.

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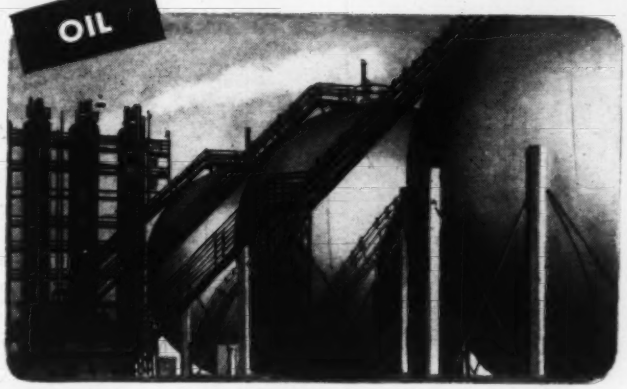
Watch industry Fluid-Drive* ahead!



1 The oil industry really puts *oil* to work in driving many of its machines through Gýrol Fluid Drive. In Gýrol Fluid Drive power is transmitted through a vortex of oil from constant speed A.C. motors for stepless adjustable speed operations on machines such as agitators, pumps, mixers, draft fans, compressors and drill rigs.

3 Smooth starting and stepless adjustable speed in a compact unit are two highly desirable features of Gýrol Fluid Drive for the textile industry. Where process requirements vary from day to day and week to week, Gýrol Fluid Drive offers a means of achieving top production on adjustable speed machines with simplicity of control.

**Gýrol Fluid Drive is a product pioneered and developed for American industry by American Blower. It is designed for applications where smooth transmission of power or stepless adjustable speed control is desired. Looking beyond the long list of applications already developed, we will work with you to find new ways to "Fluid-Drive Ahead!"*

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CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of American Radiator & Standard Sanitary corporation

2 In any industry where hard use and overload are 24-hour problems, engineers and operators recognize the safety factor that cushioned Fluid Drive introduces between motors and their loads. A few of the multitude of applications benefiting by Fluid Drive and its smooth power flow are coilers, slitters, feeder rolls, mill rolls, and conveyors.

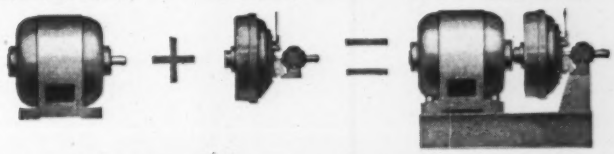
AND YOU?

4 Have you investigated critically the advantages of Gýrol Fluid Drive for your plant, processes, and products?

Over 7½-million horsepower are currently being driven through Gýrol Fluid Drive in American industry. (This figure does not include automobiles).

Yet, frankly, we feel that the opportunities for profitable applications have only begun to be explored. To this end we invite you to contact the nearest American Blower Branch Office NOW!

Rugged Constant Speed AC Motor + Type SC Fluid Drive = Smooth Power with Adjustable Speed Control



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2. *Built for continuous service.*
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IN COST

Initial cost is low—and lower still when you consider quality construction and the many operating advantages.

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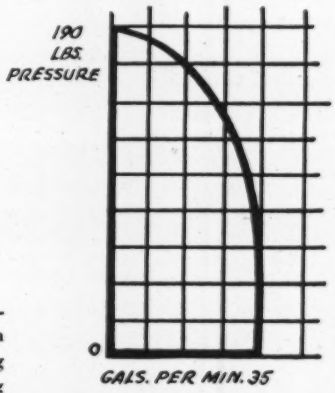

Nine Sizes, ¼ HP to 5 HP
Capacities: to 35 GPM
Pressures: to 190 lbs.

GOULDS

Write Goulds Pumps, Inc., Seneca Falls, N. Y., for complete information on this new pump. Ask for bulletin 630-A1.

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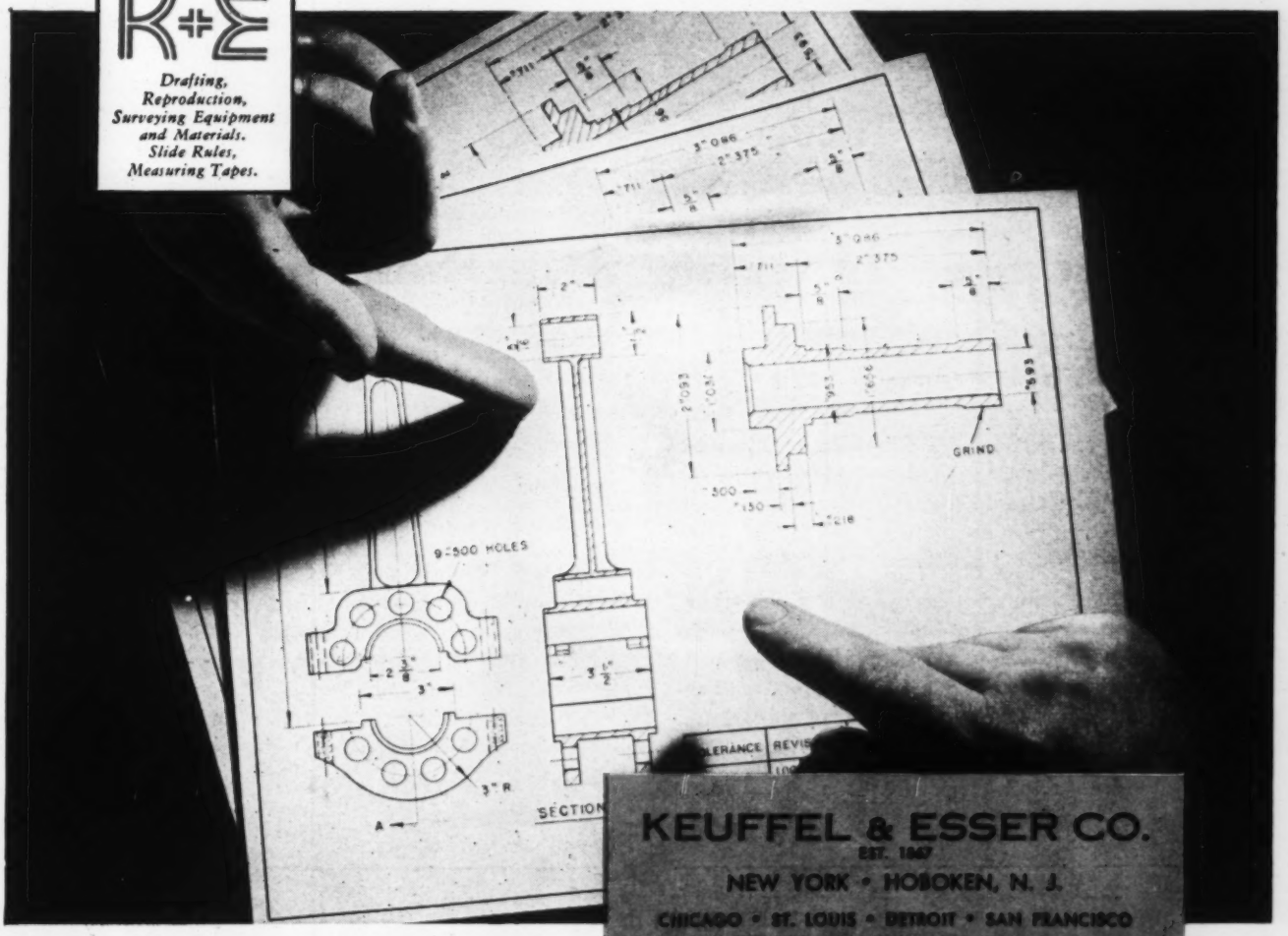

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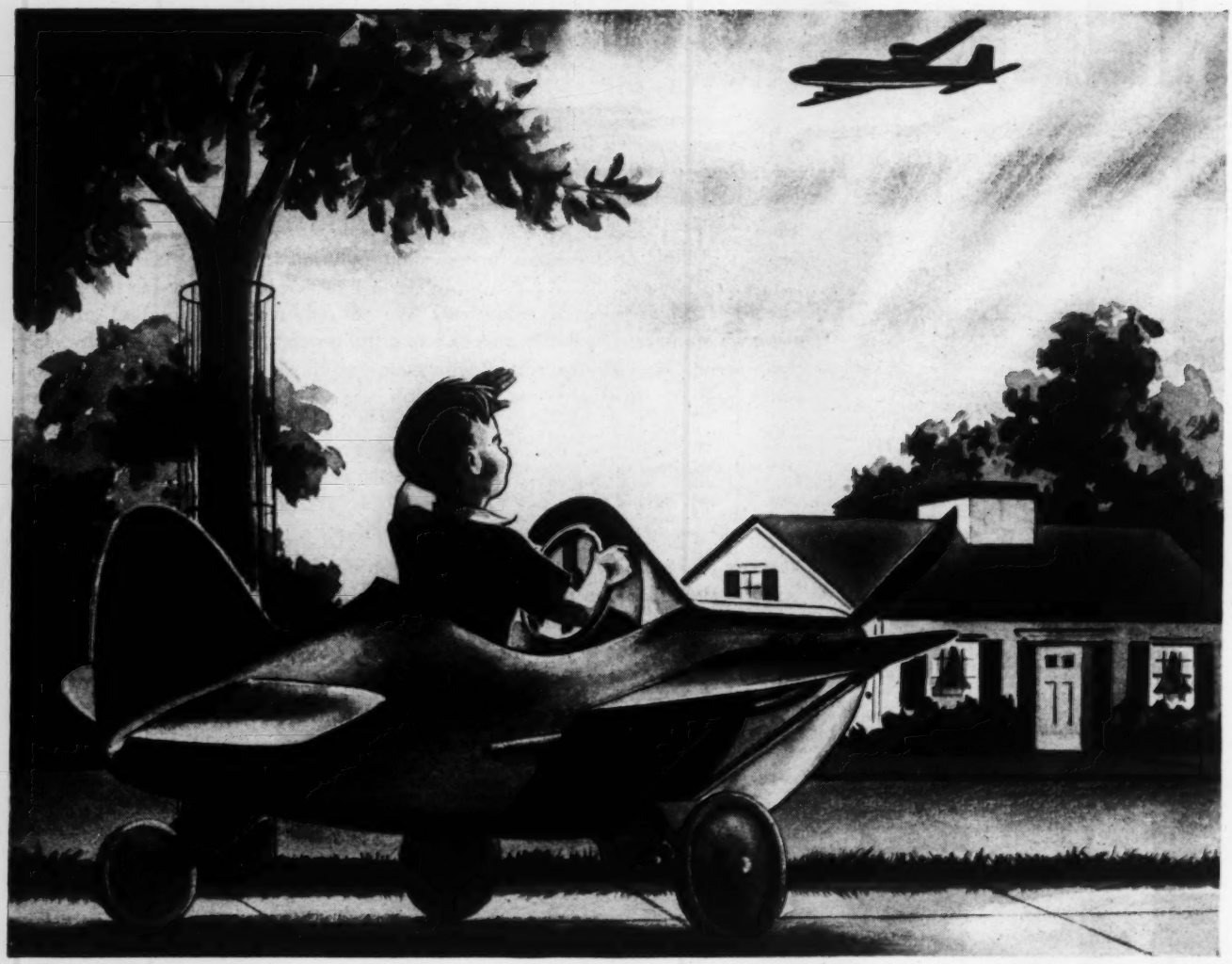

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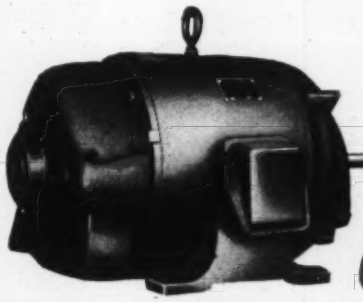
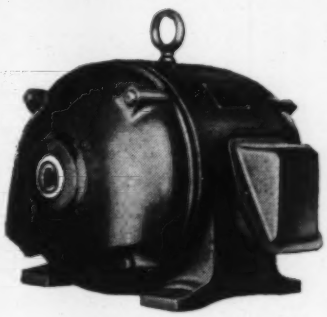
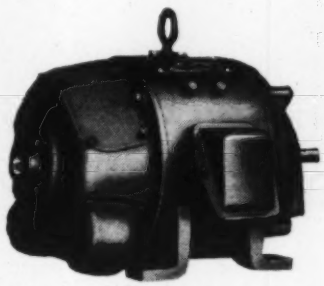


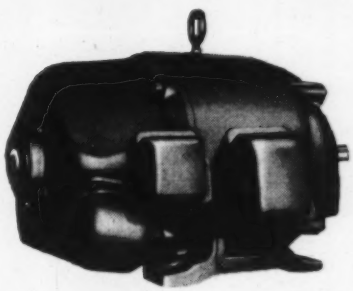
Century 7½ HP type RS Repulsion Start Induction Brush Lifting Splash Proof Motor



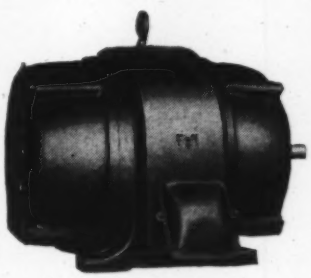
1 to 30 HP Squirrel Cage Induction 3 Phase Splash Proof Motors



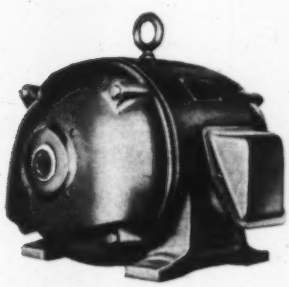
1 to 7½ HP Direct Current Splash Proof Motor



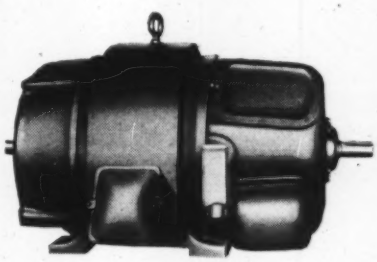
3 to 25 HP Slip Ring Induction 3 Phase Splash Proof Motors



40 to 100 HP Squirrel Cage Induction 3 Phase Splash Proof Motors



1 to 20 HP Capacitor Start Induction Single Phase Splash Proof Motor



30 to 100 HP Slip Ring Induction 3 Phase Splash Proof Motors

Century Splash Proof motor frames keep the vital parts of the motor dry—even when the full force of water from a hose is turned directly on it.

Century Splash Proof motors may help to protect the reputation of the machines you build through the protection provided in their construction—against splashing liquids, plant wash downs or falling solids.

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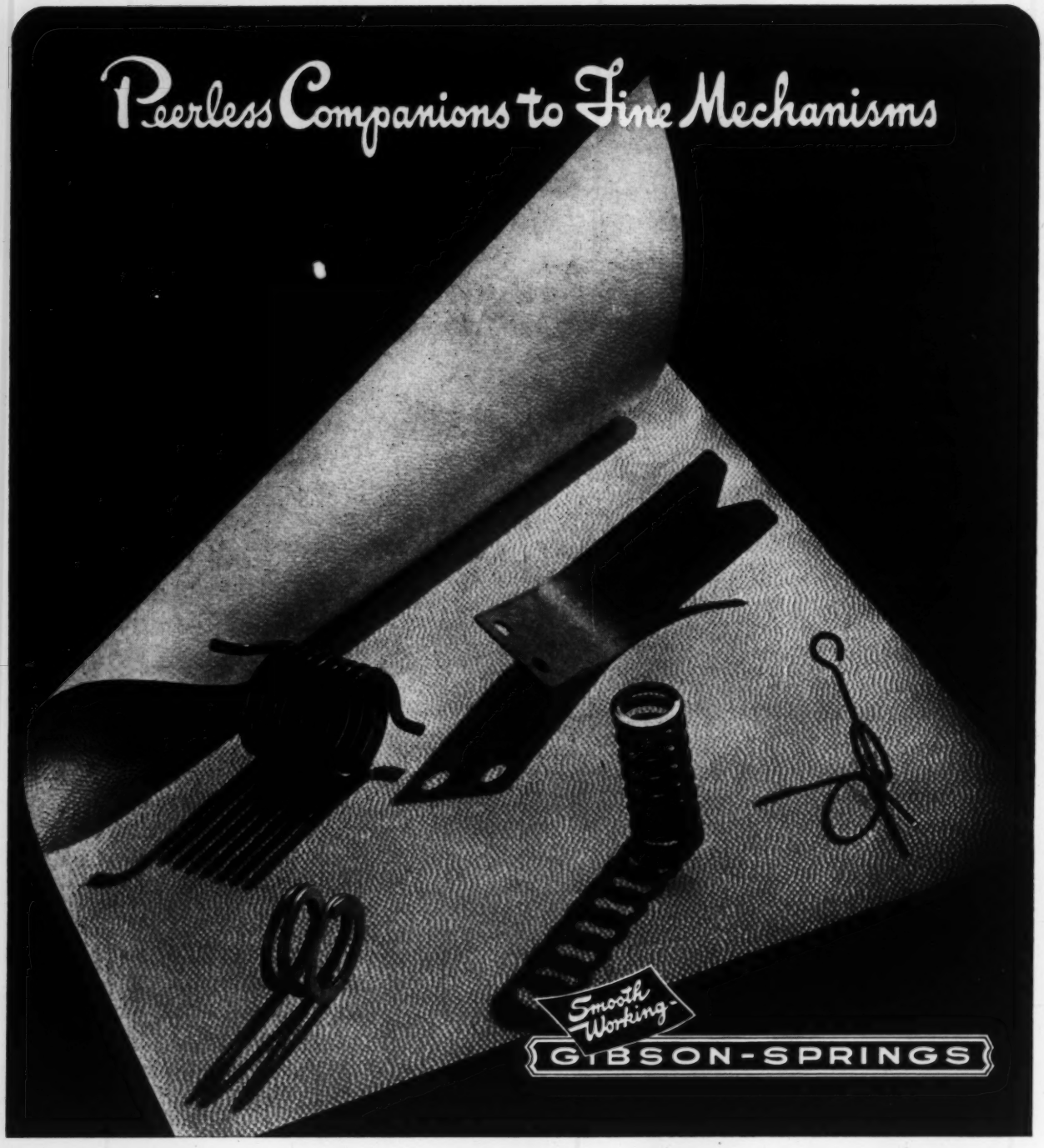

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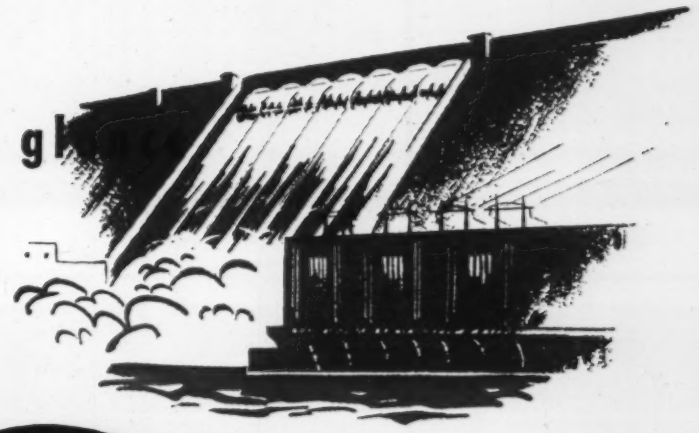
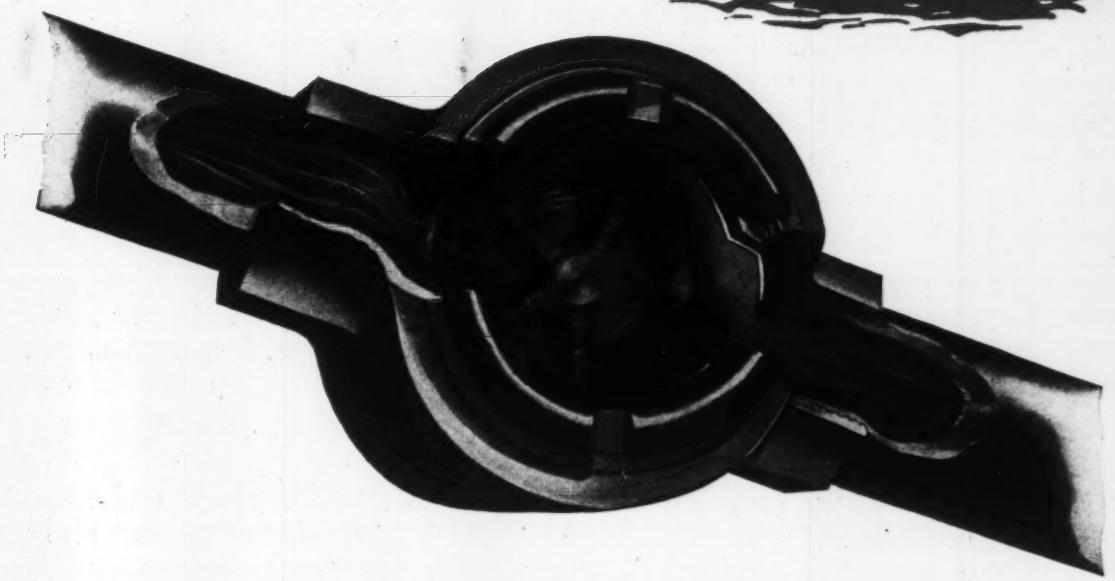
an SK "reason why"

shows flow at a gl





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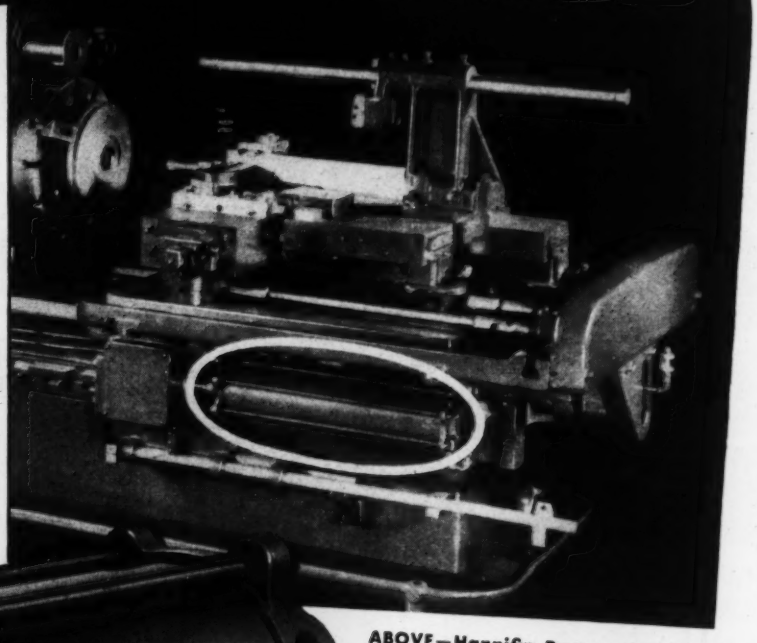
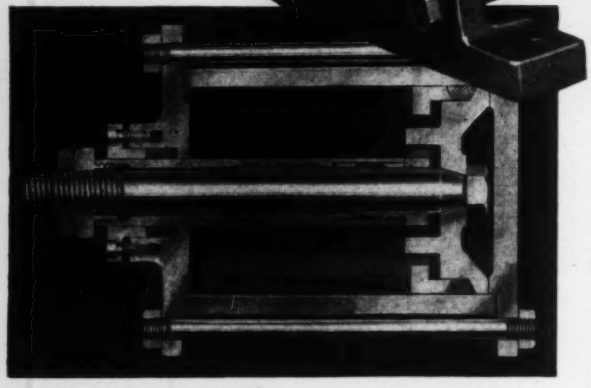
It pays to specify HANNIFIN!



ABOVE—Hannifin Pneumatic Cylinder makes traversing of carriage easy and fast on this Gisholt "Simplimatic" lathe.

HONED *Tru-Bored*

PNEUMATIC *Standardized* CYLINDERS



This cross-section view shows Hannifin's exclusive "Leakproof" design used in Series "R" Cylinders.

SMOOTH, FULL POWER PERFORMANCE. All Cylinders *"TRU-BORED"* from steel and honed to satin finish. Rods ground and polished.

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COMPLETE LINE. A wide choice of styles. Sizes 1" to 12", or larger. Any length stroke you specify. Single or double end rods. Cushion for head end, rod end or both. Ask for recommendations and Bulletin No. 57-L.

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Here is the slow speed unit so many have been asking for ever since the advent of the Axial Air Gap Motor. In over-all size the Motorgear is smaller than the average comparable motor alone: it is symmetrical in design—no separate right or left-hand assemblies. Its double reduction through helical gears means highest efficiency. Gear housing—including the feet— is a one-piece rugged casting. Above all, the Motorgear allows more and more designers and plant operators in every industry to take full advantage of the simplicity, compactness and quality built into the Axial Air Gap Motor. For full details and descriptive literature, write Fairbanks, Morse & Co., Chicago 5, Ill.

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STOKERS • SCALES • MOTORS • GENERATORS
PUMPS • FARM EQUIPMENT • MAGNETOS
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★ EXCELLENT ★ AGE RESISTANCE

RESILIENT parts made from HYCAR American rubber resist the aging effects of air, sunlight, ozone, heat, cold, and all other types of oxidation. That's why they *stay* resilient—and stay on the job for a long, long time.

Other important properties of HYCAR American rubber are shown in the box at the right. And it's important to know that these properties may be had in an almost limitless number of combinations—each compounded to meet a given set of service conditions.

We make no finished products of HYCAR. But we urge you to ask your supplier for parts made from this versatile material. You'll learn for yourself that it's wise to use HYCAR—in difficult or routine applications—for long-time, dependable performance. For more information, please write Dept. HF-10, B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio.

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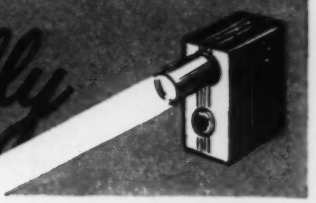
SPEED PRODUCTION SAVE MANHOURS *Photoelectrically*



Automatic Systems

CUT-OFF REGISTER CONTROL

On paper fabricating and packaging machines results in improved product appearance, cost reduction, increased production and maximum advertising value because product is clean, neat, and has greater eye appeal.

Register is maintained automatically so accurate cut-off or any other longitudinal operation in relation to printed matter is assured. Three general types available, determined by the speed of the web and the accuracy required, as well as type of mechanical correcting mechanism used on processing machine. Bulletin GEA-4371.

Side-Register Control

To keep the lateral position of a moving web in a given relation to a processing machine this side-register control is completely automatic, and any deviation in the web is instantly detected and corrected. Results in a more uniform product, cuts waste, increases production and cuts costs. Used for slitters, rewinders, side trimmers, tenter frames, etc. Can be combined with electronic - amplidyne system, or with a rotary scanner for increased flexibility. Bulletin GEA-4410.

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GENERAL PURPOSE RELAY

For counting will operate up to 400 times a minute on pulses of 1/15 second duration with a 1/15 second time lapse between pulses. Ordinary automobile headlight bulb providing at least five foot-candles at the phototube is usually used. The relay uses a standard radio tube with an expected life of several thousand hours. Any object can cut off the light beam, and reflected light may be used to identify light and dark objects. Bulletin GEA-1755F.

NOW AVAILABLE—General Electric photoelectric relay systems for almost every kind of a sorting, counting, limiting, or register job. There's an automatic system to meet every operating requirement—fast or slow, highly accurate, or standard. Save hours of routine, tiresome work requiring close attention. This electronic equipment is easy to install, easy to service—is the inexpensive way to solve many production, processing, and protection problems. Check the coupon for copies of descriptive bulletins. Control Division, Apparatus Dept., General Electric Company, Schenectady 5, N. Y.

HIGH SPEED HIGH SENSITIVITY RELAY

Useful in counting small articles, starting and stopping small motors, and as register control in paper and textile industries. A change of light of ½ foot-candle and signals as short as 1/1000 of a second operate the relay. Operates up to 1,000 times per minute. Bulletin GEC-279.

For Long Distance

OUTDOORS

Used for counting and limiting outdoors at distances up to 1000 feet. Provides protection against intruders in restricted areas and is used in connection with a warning device for hazardous locations. Also applicable for traffic control in parking lots and warehouses, shipping control in locks and harbors, and safety control for airplanes. Bulletin GEC-275.

Industrial Type

MEDIUM AND HIGH SENSITIVITY

Any object, no matter how delicate, will cut off the light beam—even smoke. Sensitive to a light level as low as 3 foot-candles in one form, as low as 1 foot-candle in the other. Operates up to 300 times a minute on light changes of 1/10 second or 1/20 second duration. Compact, suitable for vigorous, industrial-type service on conveyors, counters —useful for limiting. warning, protecting, and signalling. Bulletin GEA-5034.

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PHOTOELECTRIC CONTROLS AND HOW THEY OPERATE

Two of 12 practical lessons in industrial electronics produced for operators of this equipment under General Electric's More Power to America program. "Electronic Relay Systems" describes the simple time-delay relay circuit and the photoelectric relay. "Photoelectric Relay Systems" describes light sources and simple optical systems. Other films cover "Fundamentals of Electricity," drives and subjects of interest to all users of electronic equipment. The sound slidefilms are one-half hour each, and illustrated review booklets, and Instructor's Guide are included. More information in Bulletin GES-3303A.

GENERAL ELECTRIC

Apparatus Dept., Sec. C685–30
General Electric Company
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Please send me the coupons checked below on photoelectric relays:

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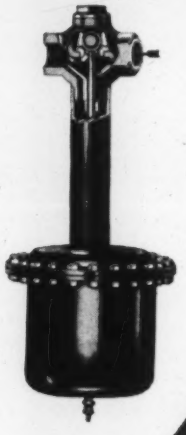

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Always

Get all the advanced features of Klipfel No. 431 air-loaded, ball type reducing valve. It's dependable for closer regulation . . . greater capacity and durability.

Hardened stainless steel ball inner valve and seat are self-aligning, tight-seating and streamlined. Accessible and durable, valve is non-sticking. Air loading in drawn steel dome varies from vacuum to 150 P. S. I. for corresponding reduced pressure. Constant loading pressure from closed to full open.

Clear neoprene diaphragm balanced between equal pressures. Pitot tube in valve body . . . no external control pipe needed. Suitable for any ordinary fluid below 250 P.S.I. initial pressure . . . vacuum to 150 P.S.I. reduced pressure.

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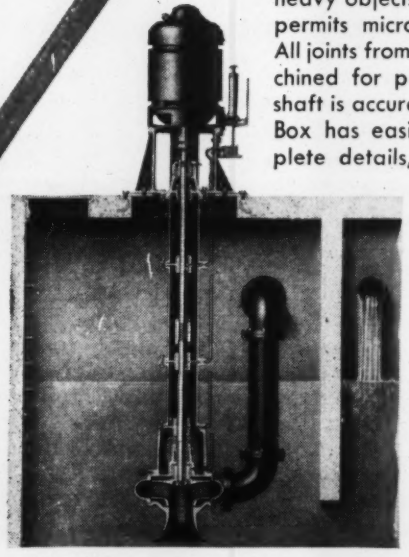
SUMP PUMPS DRAINING DOLLARS

not with Economy!

Year-in, year-out troublefree service with minimum maintenance typifies Economy Sump Pumps on the job. Screenless non-clogging impeller handles large solids . . . eliminates cleaning shutdowns. Patented shock absorber prevents deflection of shaft by heavy objects entering impeller. Adjusting Shaft Nut permits micrometer positioning of shaft assembly. All joints from motor mounting to case are closely machined for perfect register . . . heavy alloy steel shaft is accurately turned and ground. Deep Stuffing Box has easily accessible stuffing gland. For complete details, write Dept. CM-10 for Bulletin E-345.



Driving Head of 6" non-clog sewage sump pump. Intermediate bearings and shock absorber under pressure grease lubrication. Large double ball bearings lubricated in dust and moisture proof housing.

Centrifugal, axial, and mixed flow pumps for all applications.

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HAMILTON, OHIO

Recent C-E Steam Generating Units for Utilities

SEWAREN GENERATING STATION

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

THE C-E Unit illustrated here is one of three such units now in course of construction at the Sewaren Generating Station of the Public Service Electric and Gas Company at Sewaren, New Jersey.

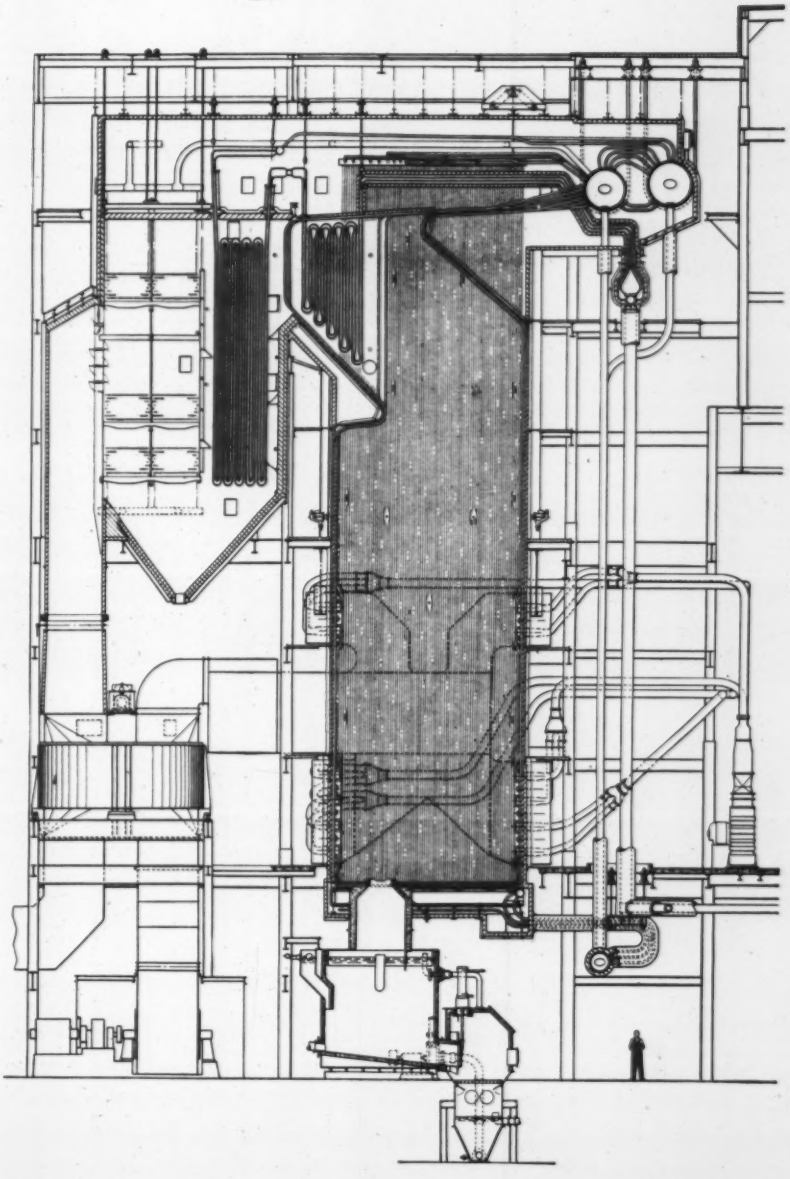
Each of these units is designed to produce at maximum continuous capacity 850,000 lb of steam per hr at 1500 psi and 1050 F at the turbine throttle.

The units are of the radiant type with 2-stage superheaters and integral finned-tube economizers in the rear pass. Regenerative air heaters follow the economizer surface. The furnaces are fully water cooled, using closely spaced plain tubes throughout. They are of the slagging bottom type.

Pulverized coal firing is employed using C-E Vertically-adjustable Tangential Burners located at two furnace levels as illustrated. Provision is made for the use of oil as an alternate fuel.

These will be the first power station units to employ a steam temperature above 1000 F.

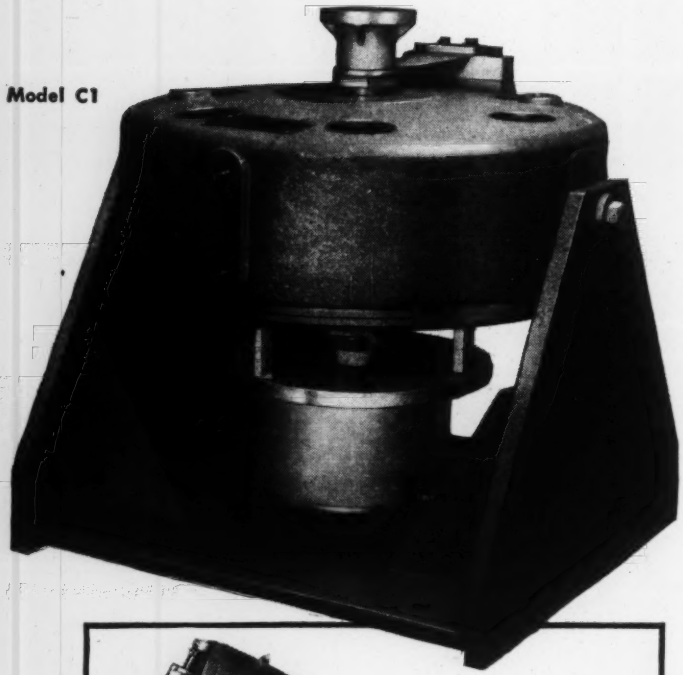
B-221

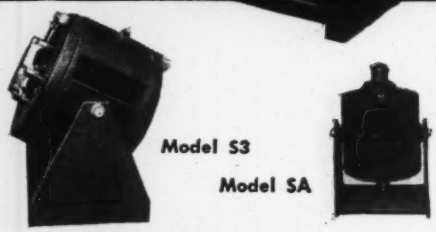


COMBUSTION ENGINEERING

200 MADISON AVENUE • NEW YORK 16, N. Y.

Product faults found in minutes with MB vibration exciters!





Note that MB Exciters can be swung to any convenient angle on the trunnion mounting.

SOME TIME AGO, a large automotive manufacturer was attempting to learn whether gas tanks could be strengthened.

They first used a mechanical shaker on a test tank in an attempt to discover possible trouble—but days went by without signs of failure. However, when an MB Exciter was attached, the tank was vibrated to destruction in a matter of *minutes!* A repeat test produced a similar failure. Based on the *visual* evidence, *which eliminated the need for any dynamic computations,* the tank was redesigned, and it was made not only *stronger,* but materially *lighter*—cutting costs as well as saving steel.

In another case, where one manufacturer's headlight bulbs were failing in great numbers, an MB Exciter fixed the blame at once—on the filament supporting arm, which was resonating at a frequency within the operating range of the car.

These cases illustrate a technique of testing that you'll find increasingly valuable as experience shows you new applications for this product improver. MB vibration exciters are now being used by many of the country's largest companies—for fatigue testing, for location of noise sources, for determining the vibratory response of products—*and the corrective measures.*

Would you like to know more about how to use this shaker in your own work? An MB engineer will be glad to give you the benefits of our specialized vibration experience.

If your product has any vibration at all— this MB VIBRATION PICKUP will detect it!

There's no practical lower limit on the amplitude of vibration you can detect with the MB Vibration Pickup—it's that sensitive! And there's no engine it can't be used on — it's that durable under high-powered pulsations!

It is a velocity-type pickup, electrically damped, with a range of 5 to 1000 c.p.s. and usable in any position. When the pickup's electrical output is fed to standard voltage measuring equipment, it can be used to check products for operating smoothness and for quality-control.

WRITE FOR FREE BULLETINS

Ask for bulletin "Vibration Testing Technique" which describes how MB Exciters are used. And Bulletin 124A will give you more details on Pickup. Write Dep't. D4.

THE **MB** MANUFACTURING COMPANY, INC.
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JUST ISSUED—YOUR NEW
1949 MECHANICAL CATALOG
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Distribution as Usual During October

The Only Reference Annual Covering the Mechanical Engineering Field with a Unique Combination of Complete Equipment Directory and Uniform Manufacturers' Catalogs. 20-page Insert Catalog of A.S.M.E. Publications is included.

The A.S.M.E. Catalog is specifically planned to serve the reference requirements of the mechanical engineer in industry. It is published by engineers annually for engineers.

Its "Directory of Industrial Materials and Equipment" provides a practically complete and authoritative index to all firms serving this field. This makes the A.S.M.E. Catalog the first reference book for locating manufacturers of products for industry.

The A.S.M.E. Catalog covers only the mechanical needs of industry. Compare its contents with like data in other reference catalogs that undertake to cover this field and see how well the A.S.M.E. Catalog meets the requirements of mechanical engineers.

The product descriptions included are extended to all quarters of the field by the listings of nearly 4,600 firms (including those giving data) in its Directory, giving access to the source of more mechanical products than any other collective catalog.

The A.S.M.E. Catalog is a highly important aid to those engineers who buy or specify for industry, since it saves time in disposing of the preliminary phases of such problems.

These firms give their latest product information in the *New* 1949 A.S.M.E. MECHANICAL CATALOG AND DIRECTORY

all consolidated in one volume for your convenience and quick reference. They will be pleased to further acquaint you with the sales merits of their products and assist your company in making the best selection to meet the conditions involved.

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THE AMERICAN SOCIETY *of* MECHANICAL ENGINEERS, 29 W. 39th St., New York 18, N.Y.

R-S valvEvents

ISSUED PERIODICALLY BY R-S PRODUCTS CORPORATION, PHILADELPHIA 44, PA., FOR THOSE CONCERNED WITH FLOW CONTROL AND SHUT-OFF

Now Tulsa Can Water its Lawns Again

Fred Gibson, Philadelphia truck driver, made it to Tulsa in 4 days from the R-S plant in Philadelphia with two big 60-inch R-S Valves riding out back on his truck.

These completed a shipment of 5 big R-S Valves for the Tulsa water supply system. The others are 54-inch valves.

All are R-S cast iron valves, cylinder-operated in connection with liquid level control for water service. All have hand-wheel and declutching unit for manual control. Angular seated vanes are lapped in for wedge-type closure.

Tulsa and surrounding areas have been suffering from a water shortage, now corrected by the new flow through the big R-S Valves controlling the new Spavinaw flow line which will deliver 35,000,000 gallons daily.

The movement and installation of the big valves was a carefully organized job. Because of speed required, full double crews were assigned so work could proceed day and night. All crews were carefully schooled in each step of procedure and in the sequence of operations.

Annyhoo, the new lines will soon be in operation; the big R-S Valves doing their stuff as usual, and Tulsa's citizens will be free of the irksome water shortage.

This is another example of the growing popularity of R-S Valves in all sizes including the largest.

New Distributor for R-S Valves in Cincinnati

The Henry P. Thompson Company, Schmidt Building, Cincinnati 2, Ohio have been appointed to represent R-S Valves in the Cincinnati area. Their territory includes Southwest Ohio, Southeast Indiana, and part of Kentucky.

The Thompson Company is an old established engineering firm. Herbert N. Haas, owner, is a graduate engineer of the University of Pennsylvania. Associated with him are John S. Bower and Kenneth C. Matthews, also graduate engineers. All are thoroughly schooled in valve engineering.

Today every R-S unit is properly engineered throughout under recognized standards for various industries such as A.S.A., A.P.I., A.S.M.E., etc. and backed up in the field by Valve Engineers.

Escalator Clauses Gripe Us, Too!

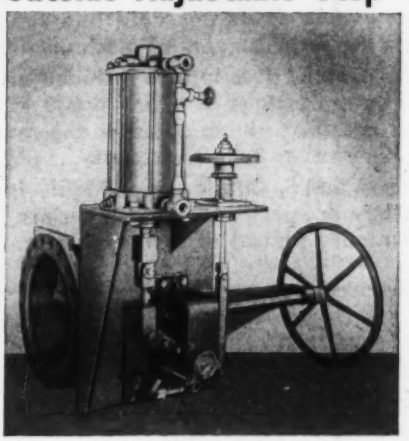
We don't even like to put one in our own contracts with customers, but wotta we gonna do?

All in one week pig iron, iron scrap, steel plate, nickel, electric motors and accessories went up from 10% to nearly 20%. All suppliers of these items have escalator clauses in their contracts.

Naturally, we have one too, to make it possible for us to stay in business.

But we don't like it any better than you do!

R-S Valve features NEW Outside Adjustable Stop



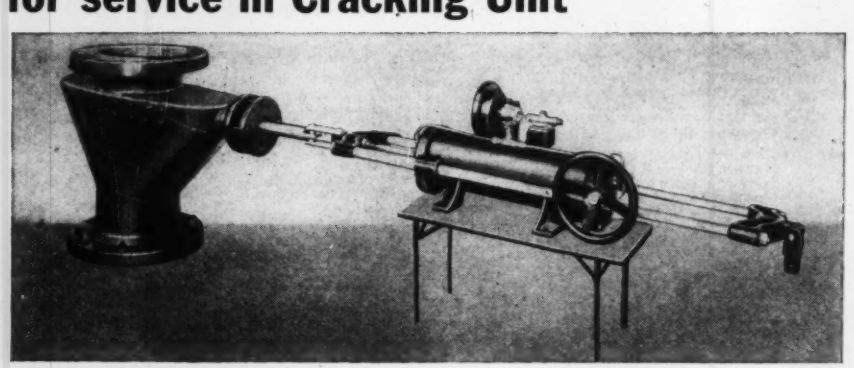
Picture shows R-S Valve #714, a 20-inch 125-pound valve with the R-S Rubber Spool (patent pending) for positive shut-off. Control is by air cylinder, cushioned at both ends. Handwheel and declutching unit are provided.

An outside adjustable stop supplies an auxiliary air cushion and may be set to control maximum opening of vane at any point from 50% to 100% open. This vane moves from full open to full closed position in 1 second.

Operating mechanism can be timed for slow movement if desired by adjusting snubbing valve in air-supply line to cylinder.

Large cylinder can be supplied for air, oil, or water pressure as actuating medium. High speed is normally provided with air only.

R-S Adds New Slide Valve for service in Cracking Unit



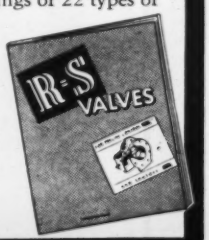
Shown above is a welded steel slide-valve, R-S #713, for handling high temperature catalyst in a cracking unit for petroleum service.

The valve is fitted with Series 30 300-pound American Standard ring-joint flanges. It is delivered complete with air-cylinder positioner and auxiliary hand-wheel control.

This R-S Valve is available with other types of automatic controls or with manual operator only, if desired.

The New R-S Valve Catalog #17

R-S Valve Catalog #17 is packed with information for engineers. There are over 70 halftone pictures of R-S Valves . . . working drawings of 21 types of R-S Valves with standard controls and fittings and complete dimensional data for all sizes . . . working drawings of 22 types of prime movers . . . numerous other diagrams, graphs and miscellaneous drawings. Address R-S Products Corporation, Valve Division, Philadelphia 44, Pa.



JM Leo 35

An Idler Wheel of LORD BONDED RUBBER

assures silent operation and perfect reproduction

in the **BRUSH**

SOUNDMIRROR*

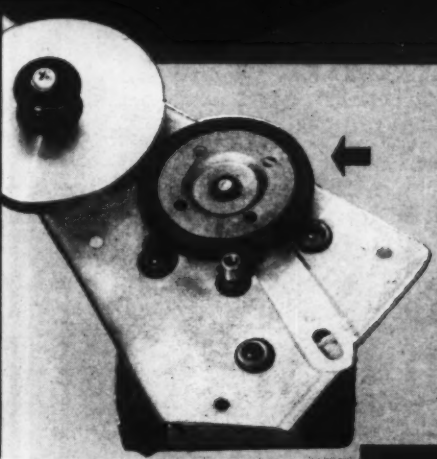
MAGNETIC RIBBON

Home Recorder-Reproducer

The design engineers of the Brush Development Company had a problem . . . they needed an idler wheel for the Soundmirror Magnetic Ribbon Home Recorder-Reproducer. It had to have precise concentricity and to be perfectly quiet in operation . . . it had to give long and trouble-free service.

They found the answer in Lord's facilities for precision control in every step of manufacture, in the perfect rubber-to-metal bond obtained by the Lord process, in the scientific selection of a synthetic rubber that combined abrasion resistance with the necessary resilience.

Rubber, natural and synthetic, with its almost infinite range of controllable properties, offers innumerable opportunities for product improvement. In many years' experience in the production of bonded rubber mountings for vibration control Lord has accumulated a wealth of experience in the application of other bonded rubber components for product improvement. Consult our engineering department for assistance in solving your problems through the use of Lord Bonded Rubber Products.



Successful operation demands perfect concentricity and a permanent rubber-to-metal bond in this idler wheel.

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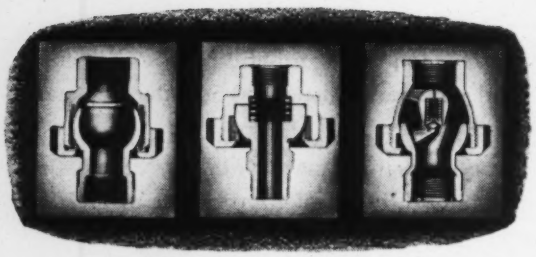
LORD

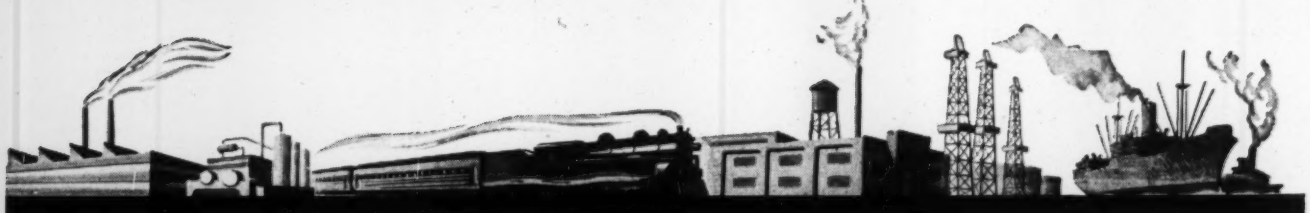
with *Vibration Control*

LORD MANUFACTURING CO. ERIE, PA.

Many operations in industry and transportation require Barco Flexible Joints in pipe lines



For over 30 years Barco has been providing the necessary flexibility and protection for fluid lines—and today Barco is standard and universally accepted. Write for information about applications in your own particular field. Barco Manufacturing Company, 1807 Winnemac Avenue, Chicago 40, Illinois. In Canada: The Holden Co., Ltd., Montreal, Canada.



BARCO FLEXIBLE JOINTS

Not just a swivel joint ...but a combination of a swivel and ball joint with rotary motion and responsive movement through every angle.

FREE ENTERPRISE—THE CORNERSTONE OF AMERICAN PROSPERITY

"MOVE IN EVERY DIRECTION"

We Studied Safety Valve *CAPACITY*

—Here's what we found out about VOLUME CONTROL

We found . . . that there's a lot more to "full capacity" than a full bored nozzle and high lift. Ability to *pass* steam and ability to *control* it are two entirely different things.

We found . . . that the first step toward control is to get rid of turbulence, and that by guiding the flow over properly designed, smooth machined surfaces, we could reduce turbulence to a negligible minimum.

We found . . . that the steam passing through a full bore exerts tremendous lifting power, tending to keep the valve open long after the overpressure has been relieved . . . but . . . when *part* of this force is spilled through an adjustable exhaust belt, the valve can handle full volume and still reseat promptly.

To you . . . this high relief capacity means fewer valves to buy—fewer valves to service. In one actual installation, 5 Foster 38-Sv's replace 12 "conventional" safety valves of the same nominal size. Other guaranteed advantages are . . . tight seating . . . consistently accurate popping . . . minimum blow-down, which can be held to as little as 1% . . . and extremely low maintenance.

For full details on the design and construction features that enable this valve to out perform any other safety valve, get in touch with your Foster Representative or with us direct.

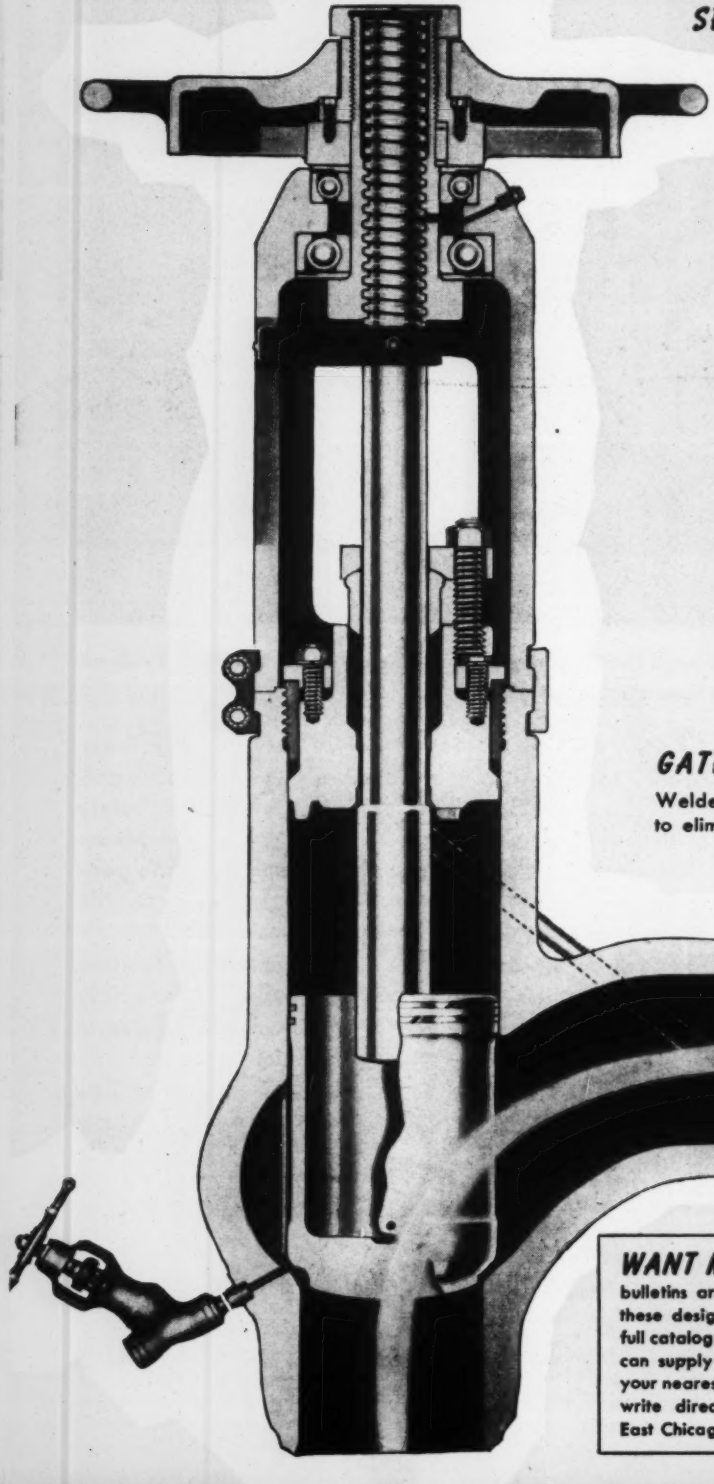
FOSTER ENGINEERING *Company*

PRESSURE REGULATORS...RELIEF AND BACK PRESSURE VALVES...AUTOMATIC STOP AND CHECK VALVES...ALTITUDE VALVES...DAMPER REGULATORS...FAN ENGINE REGULATORS...PUMP GOVERNORS...TEMPERATURE REGULATORS...LIQUID LEVEL CONTROLLERS...FLOAT AND LEVER BALANCED VALVES...NON-RETURN AND TRIPLE DUTY VALVES...VACUUM REGULATORS OR BREAKERS...SIGHT FLOW BOXES...STRAINERS...SAFETY VALVES...SIRENS

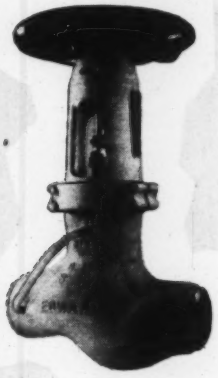
107 MONROE STREET • NEWARK 1, N. J.

They're New!

NEW PRESSURE SEAL BONNET VALVES.. NEW FORGED STEEL GLOBE VALVES.. NEW IMPACTOR HANDWHE EW GA



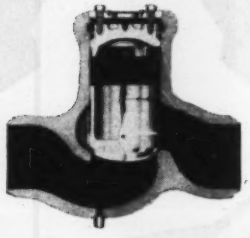
SELF-SEALING BONNET JOINTS, 30% MORE FLO



Now you can get Edward pressure-seal bo net valves in gate, globe or angle patte for stop, check or non-return service. N features for lower and lower pressure dr have been built in—and **proved.** On no oth valve series is there more proven flow da

EDWARD PATENTED EVALTHRUST YOKE BUSHIN

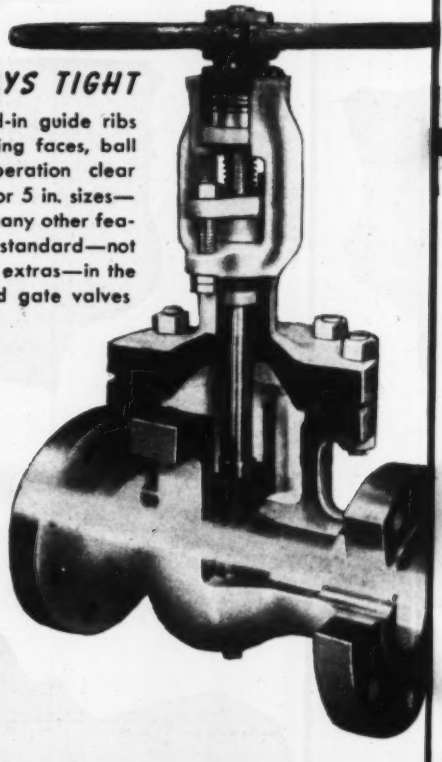
and Impactor handwheel for easiest closi in cramped locations is standard on stop a non-return series. So is closure indicator.



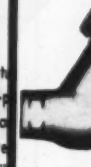
ON CHECK VALVE, left, and non-ret valve, far left, note new enclosed dash-p disk, Edward Equalizer for high disk lift a free flow passage. The whole series is re ularly built in chrome-moly steels for stabil at high temperatures.

GATE VALVE THAT STAYS TIGHT

Welded-in Stellited seats, welded-in guide ribs to eliminate wedge drag on seating faces, ball bearing operation clear down to 4 or 5 in. sizes—these and many other features are standard—not added cost extras—in the new Edward gate valves



WANT MORE DATA? Special bulletins are now available on most of these designs. A few are so new that full catalog data isn't ready yet, but we can supply dimensional drawings. Ask your nearest Edward representative, or write direct to Edward Valves, Inc., East Chicago, Indiana.



NEW
Alrea
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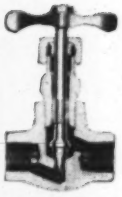
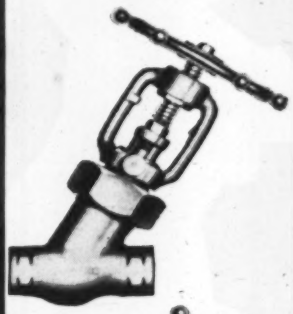
WHOLE NEW GROUP
f Edward Steel Valve Designs

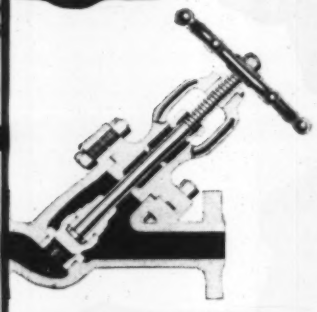
EW GAGE VALVES.. NEW WELDED BONNET UNIVALVES.. NEW BLOW-OFF VALVES... NEW GATE VALVES



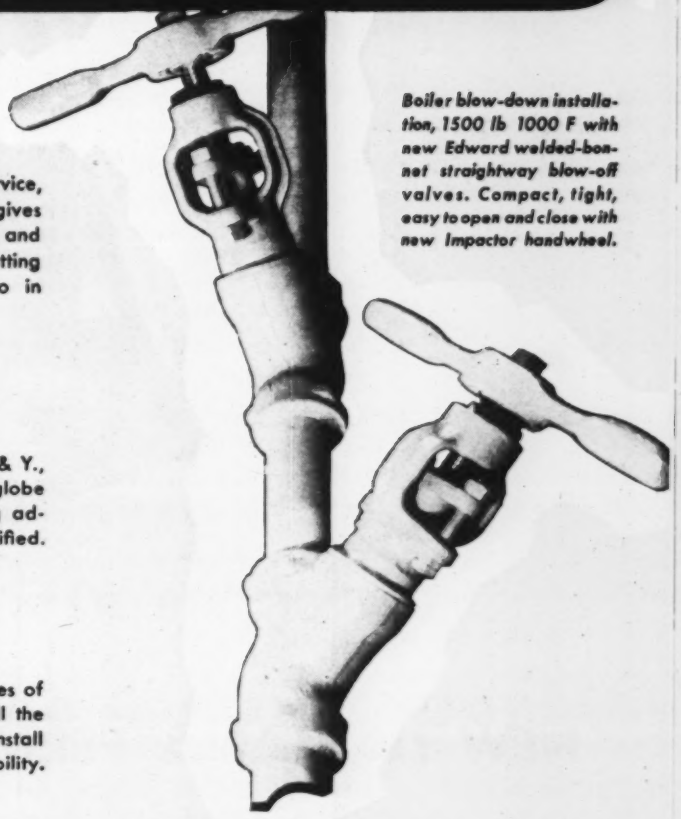
FINE REGULATION ON GAGE LINES For gage and meter service, the redesigned Edward Fig. 152 valve gives close flow regulation with small seat port and longer seat-stem contact area. New form fitting T-Handle. Rated 4000 lb W.O.G. Also in 12% Cr. and 18-8 stainless steels.



ALL-PURPOSE SMALL GLOBE VALVE Here's a new O. S. & Y., union bonnet, bolted gland forged steel globe valve for a multitude of services. Packing adjustment or replacement greatly simplified. Rated 800 lb, 750 F.



BLOW-OFF FLEXIBILITY A new series of 300 lb O. S. & Y. blow-off valves with all the design features of high pressure valves. Install them in any position for greatest piping flexibility.



Boiler blow-down installation, 1500 lb 1000 F with new Edward welded-bonnet straightway blow-off valves. Compact, tight, easy to open and close with new Impactor handwheel.

NEW, EASIER CLOSING Now the Edward Impactor handwheel, modernized and improved, is available on many small valves as well as large. Easy-to-grip cross bar delivers 2.8 times the closing load of ordinary handwheels. No wrenches or extension bars needed.

NEW WELDED-BONNET UNIVALVE

Already lowest in pressure drop among forged steel globe valves, Edward patented welded bonnet Univalves have been modified to give even less resistance to flow, less wear-producing turbulence. For top temperature service and up to 2500 lb pressure, here is the valve that offers the most.

Edward Valves, Inc.

SUBSIDIARY OF ROCKWELL MANUFACTURING CO. EAST CHICAGO, INDIANA

SEE THEM AT THE POWER SHOW

These new designs, and many other Edward and Nordstrom lubricated plug valves too, will be on display at the Edward booths, No. 26 and 27 at the Power Show, Grand Central Palace, New York, Nov. 29 to Dec. 4.

Now Ready!

INDIANA PERMANENT Magnet MANUAL No.
THE INDIANA STEEL PRODUCTS COMPANY • CHICAGO 2, ILLINOIS
PERMANENT
MAGNETS
MAY DO IT BETTER

NEW **INDIANA** PERMANENT MAGNET MANUAL

Not a catalog. Not a reprint. It's an up-to-date DESIGNER'S HANDBOOK!

Here's a new reference book that you'll want within arm's reach. From front to back, it contains helpful information about *permanent magnets*—what they are and how they're used. Air gaps and their functions . . . new magnet materials . . . energy curves and formulae . . . design procedure and construction data. All in simplified form for easy use.

This new 32-page manual, complete with 92 illustrations and graphs, reflects the design experience of more than 25,000 different permanent magnet applications. Prepared for you by the research and design staffs here at INDIANA—world's largest *exclusive* permanent magnet manufacturer. A request on your company letterhead will bring a copy to *your* desk. Write today—ask for free book No. 4-C-10.

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PRODUCERS OF "PACKAGED ENERGY"
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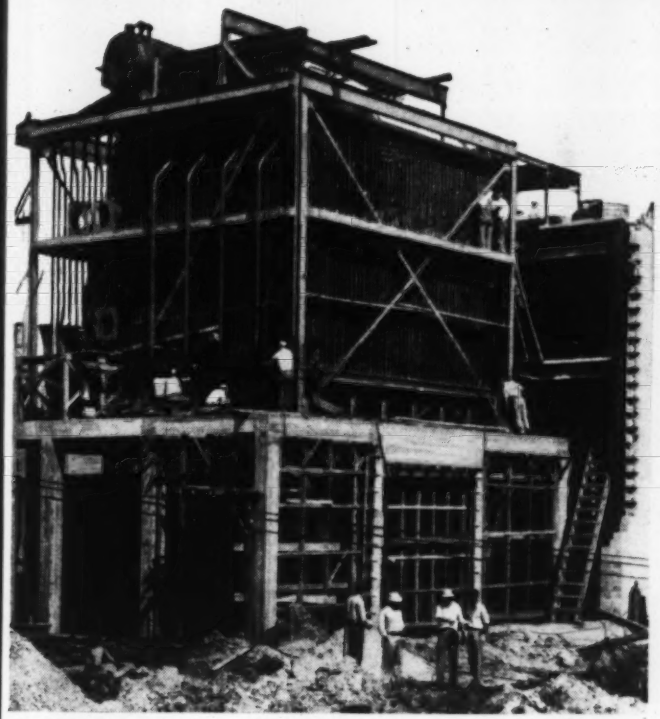
SPECIALISTS IN PERMANENT MAGNETS SINCE 1910
PLANTS: VALPARAISO, INDIANA; CHAUNCEY, WESTCHESTER COUNTY, N. Y.

DOWELL

SPECIALISTS IN SCALE AND SLUDGE REMOVAL WITH CHEMICALS



Clean That New Boiler!

REMOVE MILL SCALE AFTER ERECTION— The Chemical Way!

WHEN you install a new boiler, you'll find it to your advantage to specify removal of the mill scale *after erection*, using Dowell Chemical Scale Removal Service. The Dowell method eliminates much of the extra care required in the handling of previously sand-blasted or pickled tubes—*and* many power engineers have found that the *chemical* removal of mill scale from new boilers before the first firing results in more satisfactory boiler operation.

Unless removed, mill scale may retard heat transfer, slough off particles which abrade the system during operation, and act as a base for further corrosion.

Dowell engineers are selected for ability, trained in field and laboratory, and backed by the experience of thousands of successful jobs. They use mobile pumping equipment to fill the new boiler with specially selected liquid solvents which can reach wherever steam and water flow. They bring with them all necessary mixers, heaters and control equipment to perform the cleaning operation.

Put Dowell Chemical *Mill Scale Removal* Service in your new boiler specifications! Call on Dowell also for estimates of the cost of cleaning your present boilers, condensers, heat exchange equipment, water lines and water wells.

DOWELL INCORPORATED · TULSA 3, OKLAHOMA

SUBSIDIARY OF THE DOW CHEMICAL COMPANY

CALL

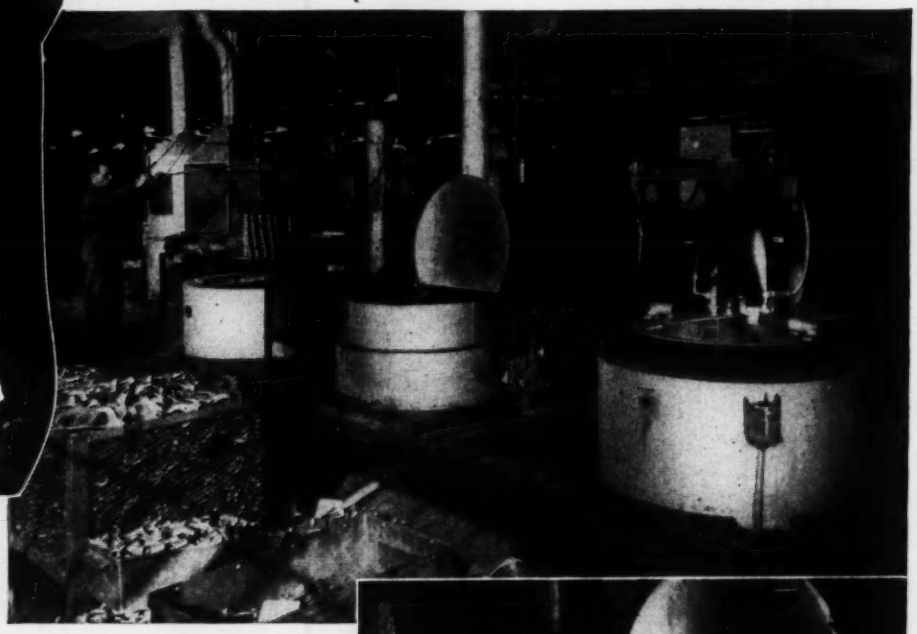
New York 20, Boston 16, Philadelphia 2, Baltimore 18, Wilmington 99, Richmond 19, Jacksonville, Atlanta, Buffalo 2, Cleveland 13, Pittsburgh 19, Detroit 2, Chicago 2, St. Louis 8, Indianapolis, Louisville, Kansas City 8, Wichita 2, Oklahoma City 2, Houston 2, New Orleans 12, Baton Rouge, Ft. Worth 2, Shreveport 23, Mt. Pleasant, Mich., Hamilton, Ohio, Charleston 27, W. Va., Salem, Illinois, Borger, Texas, Wichita Falls, Texas, Lafayette, La.

Long Beach, Oakland, Casper: Dowell Associate-International Cementers, Inc.

DOWELL

A SERVICE ORGANIZATION

Shifter fork for transmission gear is a typical part which Clark Equipment Company gas-cyanides in Homocarb Furnaces at right.



GAS CYANIDING?

Homocarb Method Solved Problem For Clark Equipment Company

In addition to gas-cyaniding of shifter-forks, Clark Equipment Company uses its Homocarbs for lugs, brake cams and brake sectors. Case thicknesses are 4 to 8 thousandths, depending on size of parts and service requirements. Temperature is nominally 1450 F, and the parts are oil-quenched.

Clark's is a mass-production plant, and requires typical mass-production results from all equipment. Homocarb gas-cyaniding meets these specifications in every detail. It regulates the four factors of gas-cyaniding—rate of feed of cyaniding medium, circulation of medium, time and temperature. Any of these factors can be changed independently of the others, to give exactly the desired results. Operator simply loads furnace, sets its automatic controls, and forgets it until time to unload. The net cost for both investment and maintenance is only a small fraction of a cent per pound of output. Since 1939 the two furnaces have run a total of over 15 furnace-years, generally 24 hours a day and often 7 days a week.

If you have a problem in cyaniding, carburizing, nitriding, tempering or tool-hardening, there's probably an L&N equipment to meet your need. An L&N engineer will be glad to tell you what it can do. Address Leeds & Northrup Co., 4963 Stenton Avenue, Philadelphia 44, Pa.

To prepare forks for heat-treatment, they are simply slid onto the spindles of the alloy heat-treating fixture. Forks are SAE 1030 steel, and the cycle time is only 1 to 1½ hours, depending on depth of case. Tonnage per hour depends of course on size of furnace; all Homocarbs are high-production units.

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

LEEDS & NORTHRUP CO.

Jrl. Ad T-623(28)

WE ARE BUILDERS

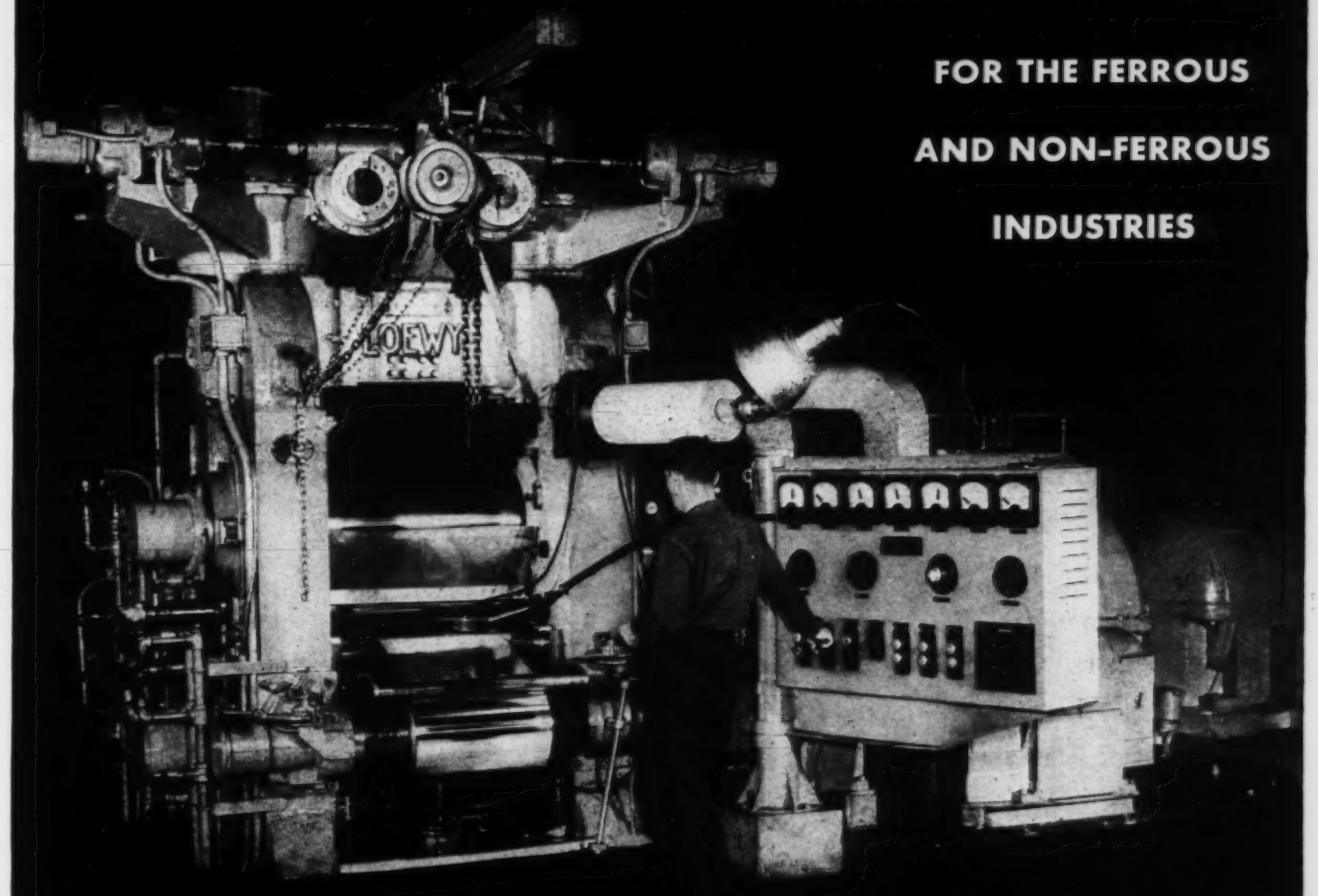
OF SPECIALIZED ROLLING MILL EQUIPMENT

BOTH HOT AND COLD

FOR THE FERROUS

AND NON-FERROUS

INDUSTRIES



BY COURTESY OF THE ALUMINUM COMPANY OF CANADA, LTD.
INSTALLATION AT KINGSTON PLANT

FOUR-HIGH
HIGH SPEED ROLLING MILL
FOR STRIP AND FOIL

HYDROPRESS · INC.

ENGINEERS CONTRACTORS

HYDRAULIC PRESSES · ROLLING MILLS · PUMPS
ACCUMULATORS · DIE CASTING MACHINES

572-574 LEXINGTON AVENUE · NEW YORK 22 · N. Y.

CHICAGO DETROIT SAN FRANCISCO SEATTLE WASHINGTON, D. C.

OUT-OF-DOORS

Power plant equipment is out-growing the confines of the conventional "boiler house" these days. Building costs are a serious bar to expansion in many cases, while adjacent space is unavailable in others. Therefore any equipment that can be installed outdoors offers welcome relief to overloaded generating plants. Cochrane Deaerators and Deaerating Heaters can be designed to suit practically any space requirement indoors, and when indoor space is not available, may be installed outside, as shown in the photographs on the opposite page. Suitably lagged, these may be installed outside in any but the coldest climates with no impairment of operation.

(upper left) Cochrane Deaerator and Horizontal Storage Tank installed outside plant of Millville Mfg. Co., Millville, N. J.

(upper right) 220,000 lb/hr. Cochrane Metering Deaerator mounted on roof of Scott Paper Co. plant, Chester, Pa. Storage tank is located inside building on floor below.

The extreme flexibility of Cochrane design as well as the inherent efficiency of the Cochrane principle of deaeration make it the most popular equipment for the protection of boiler plants against corrosion due to oxygen-bearing feedwater.

Many illustrations similar to these as well as more conventional installations are shown in Cochrane Publication No. 3005. A copy will be sent to anyone interested.

COCHRANE CORPORATION
85 YEARS OF SERVICE
1863 - 1948

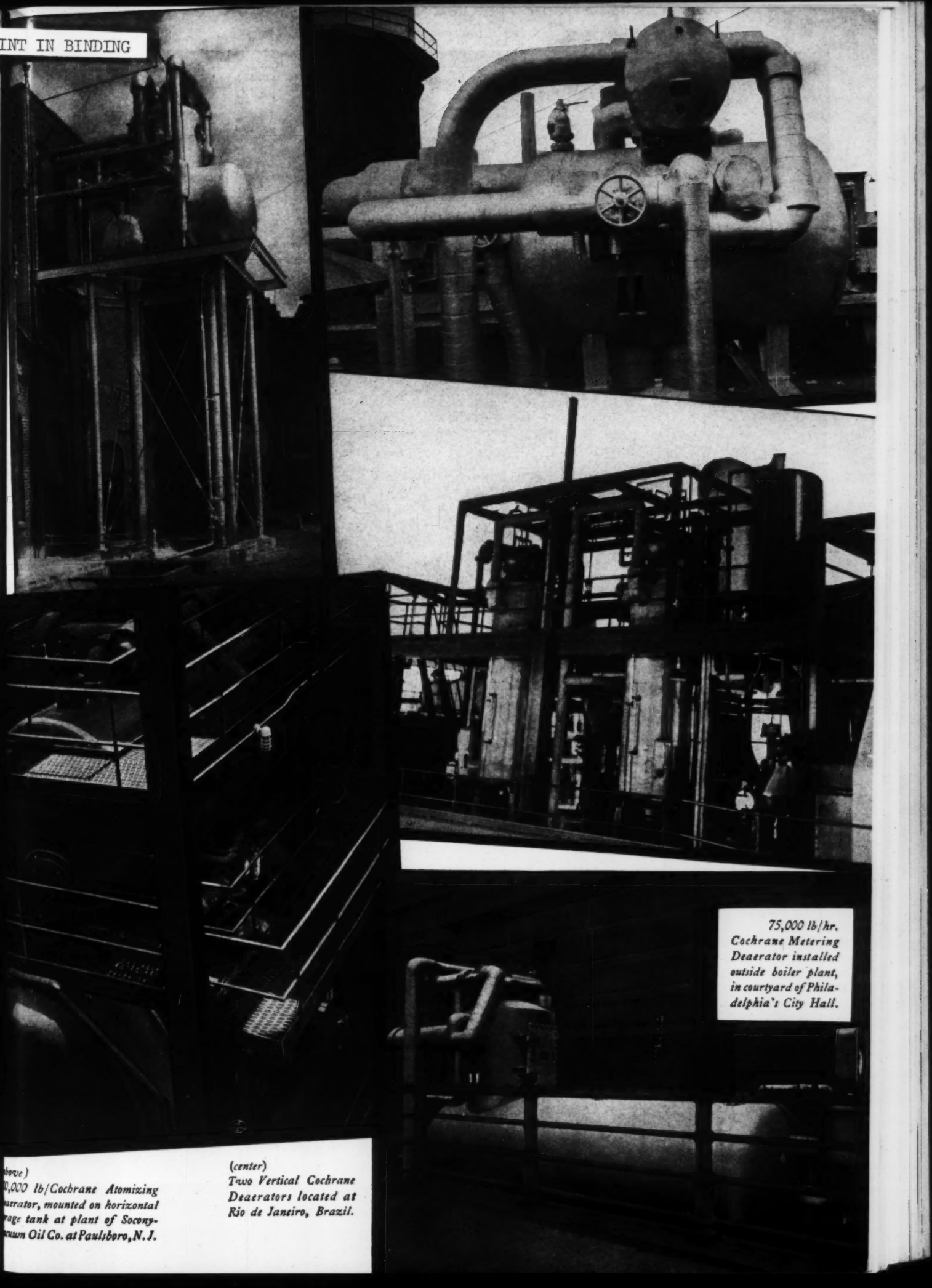
COCHRANE CORPORATION
3142 N. 17th Street, Philadelphia 32, Pa.

COCHRANE CORPORATION ★ PENNA.

COCHRANE

DEAERATORS and DEAERATING HEATERS

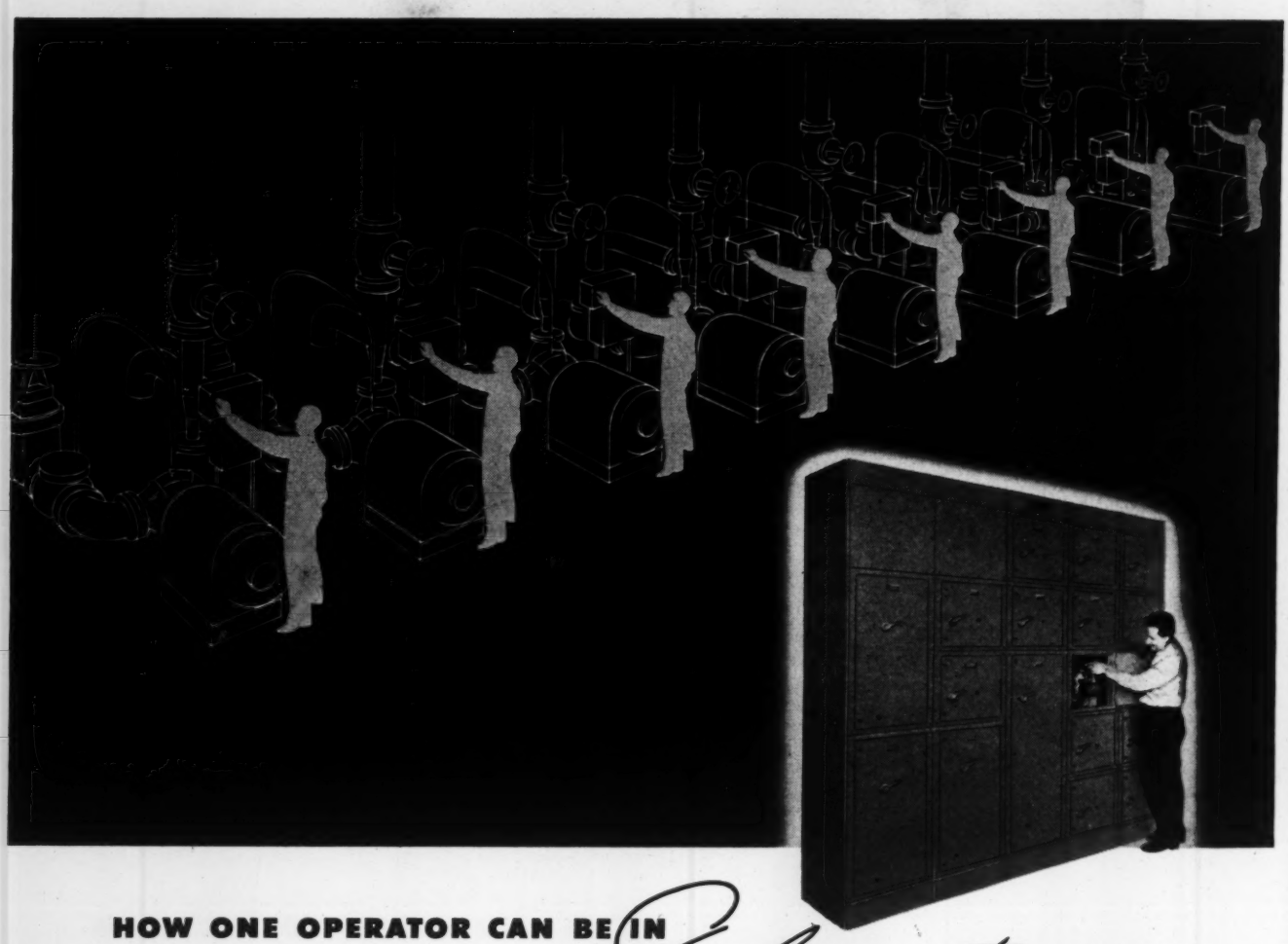
INT IN BINDING



75,000 lb/hr. Cochrane Metering Deaerator installed outside boiler plant, in courtyard of Philadelphia's City Hall.

bove)
0,000 lb/Cochrane Atomizing aerator, mounted on horizontal rage tank at plant of Socony-cuum Oil Co. at Paulsboro, N.J.

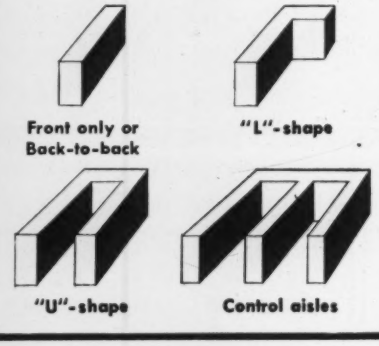
(center)
Two Vertical Cochrane Deaerators located at Rio de Janeiro, Brazil.



HOW ONE OPERATOR CAN BE IN *8 places at once*

INVESTIGATE!

Westinghouse Control Centers are ideally suited for nearly any kind of floor arrangement—with front only or back-to-back mounting. Below are some of the flexible arrangements possible to suit your special needs.



Putting skilled operating men in several places at once is a practical step toward producing *faster, better, cheaper.* That's why more and more plants are installing modern Westinghouse Control Centers.

In one place, a single operator can handle all units of a synchronized operation and at a glance can determine whether the operation is functioning properly. In case of trouble, the operator can spot its source immediately. Costly "run-around" time is eliminated...which means fewer production delays, lower maintenance costs.

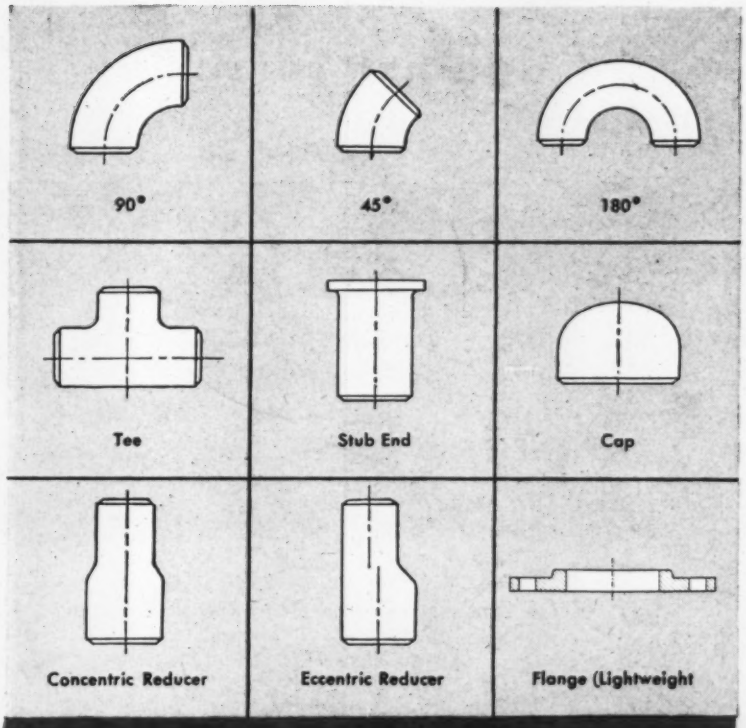
In a typical installation, a Westinghouse Control Center regulates the starting sequence of eight pumps, to supply a constant pressure level for a locomotive boiler servicing system. Cost of the centralized control installation was actually *less* than it would have been for individual controls located at each pump.

Ask one of our sales engineers to show you how the Westinghouse Control Center standardized units can be arranged to suit *your* special needs. Phone your nearest Westinghouse office, or write Westinghouse Electric Corporation, Dept. T, P. O. Box 868, Pittsburgh 30, Pa. J-85009

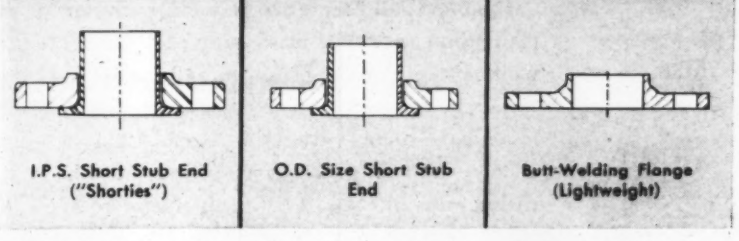
Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

MORE PRODUCTIVE POWER FOR INDUSTRY



A NEW SLANT ON FLANGED CONNECTIONS



Seamless stub ends for 10-S and 40-S piping with 150 lb. A.S.A. carbon steel lap joint flanges.

Seamless stub ends for O.D. tubing sizes with 150 lb. A.S.A. carbon steel lap joint flanges.

Lightweight stainless flanges (125 lb. American Standard diameter and drilling) for butt-welding to Schedule 10-S pipe.

TAYLOR FORGE WeldELLS and FLANGES

UNIFORMLY EXCELLENT

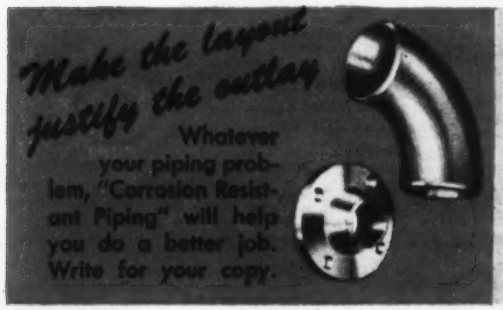
. . . . for conditions requiring:
Product Purity
Corrosion Resistance
Extremely High Temperatures
Extremely Low Temperatures
Maximum Economies

Available in Stainless 304, 316, 347, Monel, Inconel, Nickel, Copper; also other usual industrial metals.

Fitting sizes: ¾" through 12" and larger. Wall thicknesses: schedules 40S, 80S, 10S and others. Flange sizes: ¾" through 30" and larger.

TAYLOR FORGE

TAYLOR FORGE & PIPE WORKS General Offices & Works: Chicago 90, Ill. (P. O. Box 485) Eastern Plant: Carnegie, Pa.
District Offices—New York: 50 Church Street • Philadelphia: Broad Street Station Bldg. • Chicago District Sales: 208 S. LaSalle Street
Houston: City National Bank Bldg. • Los Angeles: Subway Terminal Bldg.


Make the layout justify the outlay
Whatever your piping problem, "Corrosion Resistant Piping" will help you do a better job. Write for your copy.

Send me "Corrosion Resistant Piping"

Name_____

Position_____

Company_____

Street Address_____

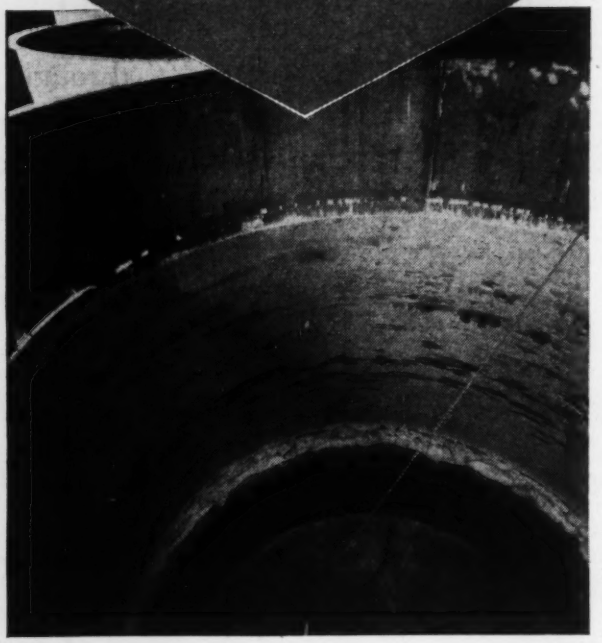
City_____ Zone_____ State_____

504-1048

Mail to Taylor Forge & Pipe Works
P. O. Box 485, Chicago 90, Illinois

ALL 12 are *protected* against corrosion

at the LIQUID LEVEL



Nickel-Clad Steel was used in the top courses of these soap kettles built by Philadelphia Iron Works, Inc., of Philadelphia.

Soap makers know that carbon steel kettles corrode at the liquid-air level. They replace corroded sections with courses of Lukens 10% Nickel-Clad Steel, securing the corrosion resistance of *solid* nickel at the lower cost of *clad* steel.

Lukens Clad Steels are providing similar protection for other processing equipment, while also preventing contamination of materials being processed. Nickel-Clad, Stainless-Clad, Inconel-Clad or Monel-Clad is chosen according to the character of corrosion encountered. A uniform thickness of cladding—10% or 20% of total plate thickness—is permanently bonded to a steel backing plate.

The extra smooth Sodium Hydride Finish now available on Lukens Clad Steels makes cleaning even easier than before.

Lukens Bulletins 255 and 338 contain information that will help you adopt Lukens Clad Steels for your processing equipment. For a copy, write Lukens Steel Company, 402 Lukens Building, Coatesville, Pennsylvania.

CLAD METAL STEEL

Visit us at the Shows!

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The National Chemical Exposition
Chicago Coliseum
October 12 thru 16

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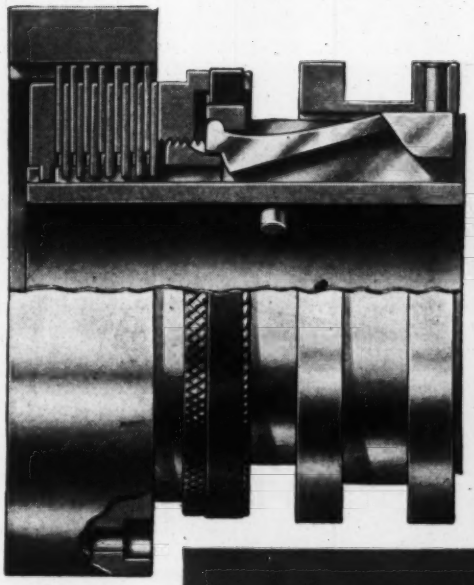
October 25 thru 29

LUKENS

Nickel-Clad Stainless-Clad
Inconel-Clad Monel-Clad
STEELS

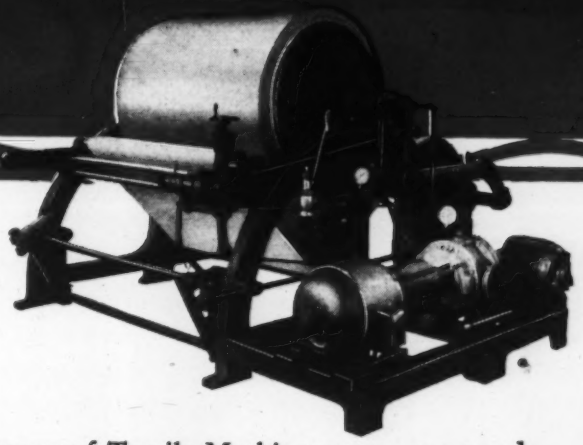
SOLID METAL ADVANTAGES WITH CLAD STEEL ECONOMY

• • SPEED SCRAP TO THE MILLS TO MAKE MORE STEEL • •



MAXITORQ

KEEPS GOOD COMPANY



Among manufacturers of Textile Machinery are many good friends of the Maxitorq Floating Disc Clutch. For instance, the Van Vlaanderen Machine Company which uses a double Maxitorq for control of the forward and reverse drive in their well known Decating Machine, used for treating certain fabrics with live steam.

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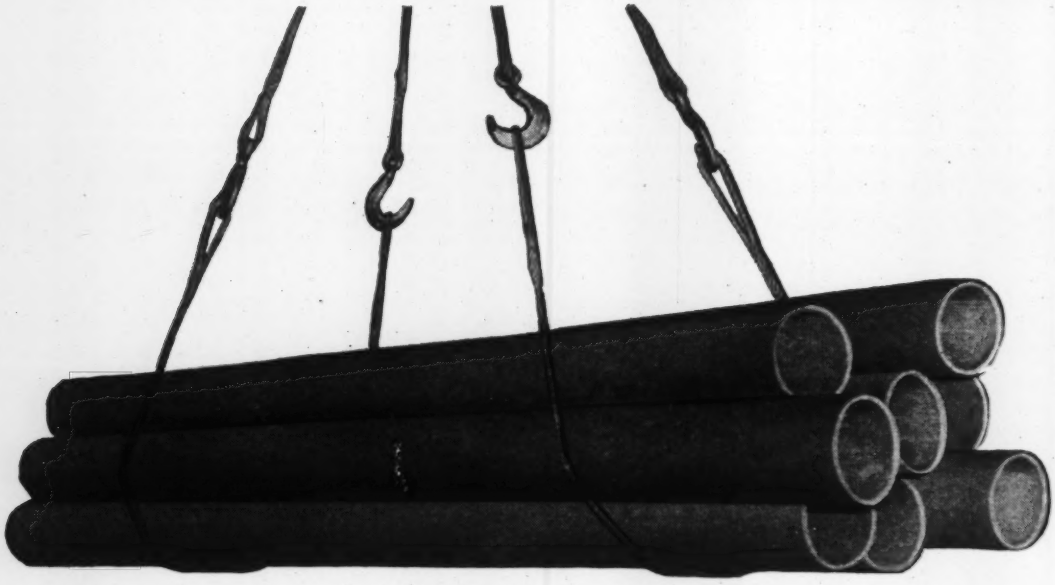

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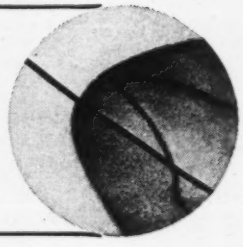

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MECHANICAL ENGINEERING

Published by The American Society of Mechanical Engineers

VOLUME 70 NUMBER 10

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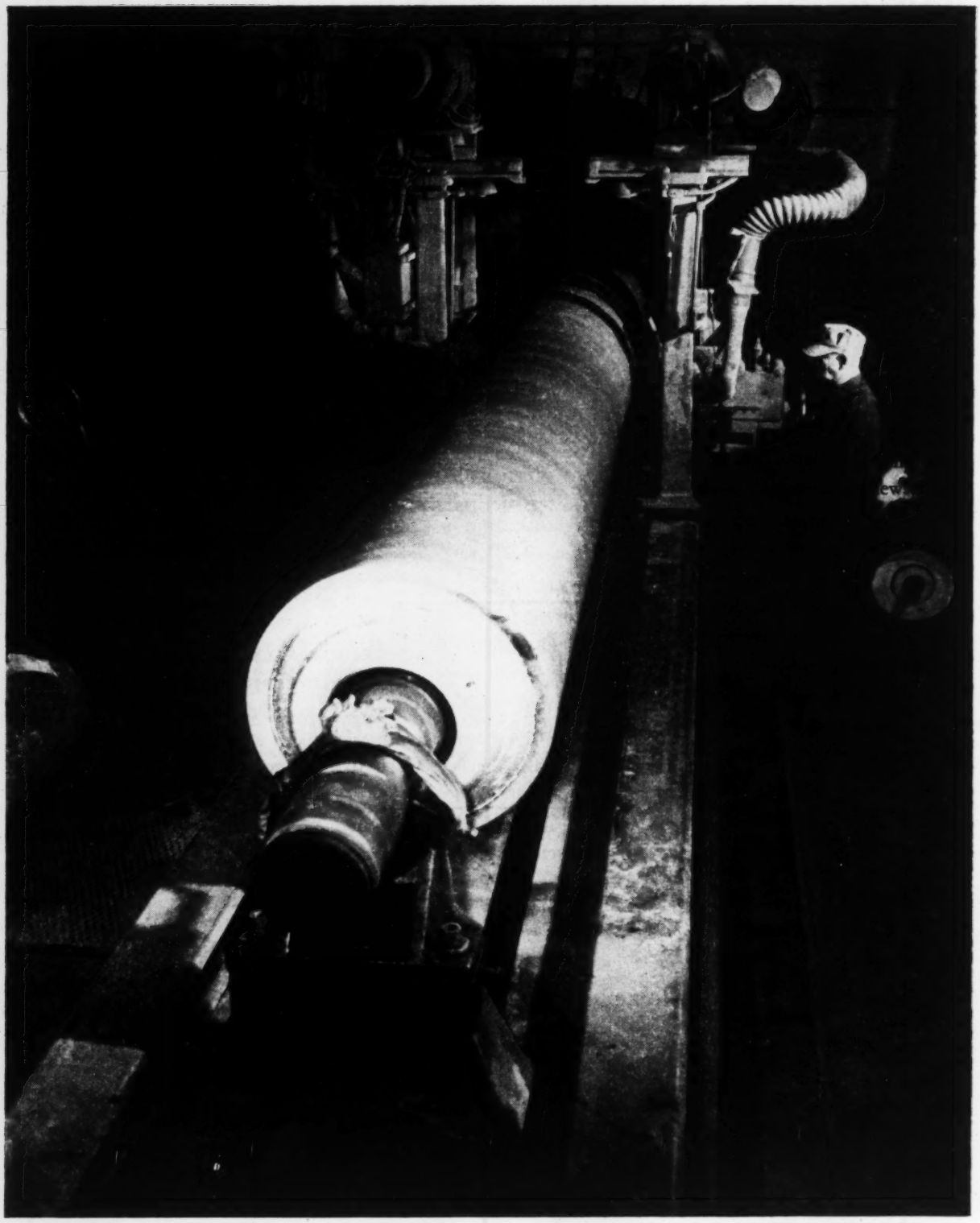
Published monthly by The American Society of Mechanical Engineers. Publication office at 20th and Northampton Streets, Easton, Pa. Editorial and Advertising departments at the headquarters of the Society, 29 West Thirty-Ninth Street, New York 18, N. Y. Cable address, "Dynamic," New York. Price 75 cents a copy, $7.00 a year; to members and affiliates, 50 cents a copy, $4.00 a year. Postage outside of the United States of America, $1.50 additional. Changes of address must be received at Society headquarters three weeks before they are to be effective on the mailing list. Please send old as well as new address. . . . By-Law: The Society shall not be responsible for statements or opinions advanced in papers or . . . printed in its publications (B13, Par. 4). . . . Entered as second-class matter at the Post Office at Easton, Pa., under the Act of March 3, 1879. . . . Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized on January 17, 1921. . . . Copyrighted, 1948, by The American Society of Mechanical Engineers. Member of the Audit Bureau of Circulations. Reprints from this publication may be made on condition that full credit be given MECHANICAL ENGINEERING and the author, and that date of publication be stated.

MECHANICAL ENGINEERING is indexed by the Engineering Index, Inc.



Rubber-covered roll used by a paper company being ground to size in the plant of The B. F. Goodrich Company, Akron, Ohio

MECHANICAL ENGINEERING

VOLUME 70
No. 10

OCTOBER
1948

GEORGE A. STETSON, *Editor*

United Nations Day

THE General Assembly of the United Nations, on Oct. 31, 1947, adopted a resolution naming October 28 as "United Nations Day" and invited all member governments to co-operate in observing it. The resolution declared that the day "shall be devoted to making known to the peoples of the world the aims and achievements of the United Nations and to gaining their support of the United Nations." This month is the first occasion on which United Nations Day is to be celebrated. Engineers, as citizens and as professional men, will find much significance in the United Nations for them and are urged to co-operate in whatever local observances of United Nations Day may be instituted in their communities.

The Charter of the United Nations opens with these words:

"We the peoples of the United Nations determined to save succeeding generations from the scourge of war, which twice in our lifetime has brought untold sorrow to mankind, and to reaffirm faith in fundamental human rights, in the dignity and worth of the human person, in the equal rights of men and women, and of nations large and small, and to establish conditions under which justice and respect for the obligations arising from treaties and other sources of international law can be maintained, and to promote social progress and better standards of life in larger freedom, and for these ends to practice tolerance and live together with one another as good neighbors, and to unite our strength to maintain international peace and security, and to ensure, by the acceptance of principles and the institution of methods, that armed force shall not be used, save in the common interest, and to employ international machinery for the promotion of the economic and social advancement of all peoples, have resolved to combine our efforts to accomplish these aims."

No responsible citizen will dispute these high aims, contained in the Charter which came into force on Oct. 24, 1945, as the twenty-ninth nation deposited its instrument of ratification.

It is through the United Nations Educational, Scientific, and Cultural Organization, or UNESCO, that engineering societies have their closest contacts with the United Nations. A brief description of the engineering aspects of UNESCO will be found on page 819 of this issue. As that article points out, science is represented on the U. S. National Commission for UNESCO by 12 of its 100 members. Eight of these persons represent organizations. Among these are the American Society for Engineering Education, whose representative, Huber O. Croft, is a member of ASME, and the Engineers Joint Council, whose representative is Robert M. Gates, past-president ASME. To advise Mr. Gates, EJC has appointed a committee consisting of Harold C. Dean, Ralph L. Goetzenberger, George C. Heikes, Augustus B. Kinzel, Albert B. Newman, Stewart E. Reimel, Clifford S. Strike, and Richard H. Tatlow, 3rd.

On January 1, Mr. Gates wrote a letter to Dr. Milton S. Eisenhower, chairman, U. S. National Commission for UNESCO, and summarized engineering activities and facilities, in which he said: "Realizing the importance of our work in modern civilization, we have long awaited the opportunity for further co-operation and mutual assistance that UNESCO now makes possible." This letter was published in MECHANICAL ENGINEERING, March, 1948, page 270.

Mr. Gates, who attended the Second Session of the UNESCO General Conference in Mexico City last fall, reports that his committee hopes that, through the co-operation of the program committees of the societies in the Metropolitan area, a joint UNESCO meeting can be arranged. In co-operation with EJC's Committee on International Relations, he says, Dean S. S. Steinberg is making a trip for the State Department in South America in an effort to develop closer relationships in engineering education. Mr. Gates also reports that his committee has been in contact with Mr. Posse, of Argentina, who brought to this country a copy of the constitution of a Union Panamericano de Ingenieros. Interest in the proposed organization has been expressed and word has been received of a contemplated meeting in Brazil in 1949 to discuss the subject.

The first issue of the *Bulletin*, June, 1948, of the World Engineering Conference, mentioned in the article on page 819, refers to the activity of engineers in UNESCO and reprints a portion of the article, "Engineers Are Also Citizens," written by Mr. Gates and published in the June, 1947, issue of MECHANICAL ENGINEERING.

The foregoing and other evidences of the desire of engineers to participate in international affairs testify to their potential interest in UNESCO and its program.

In a statement by George C. Marshall, Secretary of State, before the House Foreign Affairs Committee on May 5, 1948, five ways to strengthen the United Nations are listed: The "successful completion of the European Recovery Program," in which many engineers are already engaged; the strengthening of our own "military posture;" our "ability to protect international law and order;" the strengthening of the "military posture of our friends;" the promotion of "associations of like-minded states within the framework of the United Nations;" and support of "specific efforts to strengthen

the United Nations and help remove the causes of war."

It will be noted that Secretary Marshall's program begins with ourselves. A strong United States of America is essential to a strong United Nations. A cynical internationalism or antinationalistic attitude which has little faith in America and its institutions, that is not loyal first and always to the United States of America can be of little aid to the United Nations. We must begin with ourselves to develop an intelligent and active citizenship program for this country if we would ever hope to develop intelligent and active citizenship in the world.

Through its Engineers Civic Responsibility Committee which the late Roy Wright did so much to foster and advance, the ASME has an organized medium through which good citizenship and pride of country are being brought to the attention of engineers. Its program of making engineers good citizens of the United States is a start on a program of making engineers good citizens of the world—of strengthening the United Nations.

Not on October 24 only but on all occasions engineers and engineering groups should give thought to the United Nations. Not only the EJC and Mr. Gates' committee but all groups and all sections—particularly the Student Branches—should strive continually to make their members good engineers, good citizens of the United States, and good citizens of the United Nations. "Wise, patient, and persistent a tion," said Secretary Marshall," will lead to the development of a strong United Nations and the fulfillment of its tasks."

ASME Transactions

A YEAR has passed since members of The American Society of Mechanical Engineers voted by letter ballot, about 8 to 1, to modify the Society's publication procedure and place the Transactions, including the *Journal of Applied Mechanics*, on a subscription basis. The new plan was approved by the Council ten months ago and was put into effect on Jan. 1, 1948. As of the first of this year members have received Transactions and the *Journal* only if they have subscribed to them.

Decision to substitute paid subscription for free distribution was based on the increased number of technical papers recommended for publication and on rising costs. Events have justified the action taken: No indication exists that the number of papers has reached a peak; and twice during the current calendar year printing prices have been raised. Only because of the modification put into effect last January has the Society been able to carry on its publication program within its budget. During the coming fiscal year it will be necessary either to increase the budgetary appropriations for publications adopted by the Council last June or to effect further economies.

One feature of the modified ASME publication plan has greatly increased service to members. Beginning with the January, 1948, issue a new department, "ASME Technical Digest" was added to MECHANICAL ENGINEERING, the magazine which every member of the Society receives monthly. In this department appear from month to month digests of all papers that are presented at ASME meetings for which manuscripts are available. To judge from the results of the Reader Interest Survey, this new department is well received. As the only ASME meeting papers that do not appear in digest form in this department are published in full or in condensed form in the text pages of MECHANICAL ENGINEERING, readers now have a service which brings to their attention every ASME meeting paper. Never before has this complete service been available. Formerly a majority of ASME meeting papers recommended for publication were available in MECHANICAL ENGINEERING, Transactions, and the *Journal of Applied Mechanics*. But this represented only about half of the papers presented. Under the present scheme the reader will find either the complete paper, or a condensation or a digest of every other paper, in MECHANICAL ENGINEERING, and he can purchase complete copies of papers not published in full at low rates. Boxed notices in the two departments, "Briefing the Record" and "ASME technical Digest," tell the reader how to procure these complete copies.

It is recognized that libraries and a relatively few engineers prefer the magazine to the individual-copy form of ASME technical papers. In such cases subscriptions to Transactions or the *Journal of Applied Mechanics*, or both, should be entered, or the bound annual volume, which contains both, should be purchased. Readers whose needs are met by relatively few individual papers, brought to their notice by the monthly digests in MECHANICAL ENGINEERING, will find the coupon-book plan of purchase easy and economical.

Early in 1949 the Publications Committee and the Board on Technology of ASME plan to review the Society's publication procedures to see if further modifications should be made. Suggestions and comments are solicited.

Aid to Young Men

IN an article found on pages 815 to 817 of this issue Clarence E. Davies, secretary ASME, reviews some of the "difficulties young men contend with" and suggests a program in support of post-college engineering training. His program is directed to the Engineers' Council for Professional Development, the national engineering societies, local engineering societies or groups, the engineering schools, and the employers of engineering graduates. Every engineer fits into one or more of these classes. If you are one of the many who wish to do something for young engineers, the opportunity lies ahead of you to do something more than to be indignant or to talk about it Improvement will come when plans are wisely laid, programs are organized, and activities are co-ordinated. Success is achieved and gains are consolidated on the firing line. Not everyone can exercise effective leadership or is in a position to determine policy. But everyone is associated in some way with young men and with organizations, and that is where everyone can help lessen the difficulties young men contend with.

EXPERIMENTAL ENGINEERING RESEARCH METHODS

By C. E. LUCKE

COLUMBIA UNIVERSITY, NEW YORK, N. Y. FELLOW ASME
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INTRODUCTION

EXPERIMENTAL engineering research is a method of solving engineering problems. The word "experimental" implies testing, but testing is not in itself research. Engineering research may also be done on paper only, which is less costly but of course cannot always produce the desired answers. In the last analysis, neither method is as expensive as field experimentation, in terms of both money and prestige.

The steps of research are as follows:

1 Paper research, using all available references to determine what testing, if any, must be done.

2 Experimentation to obtain necessary fact data with an interpretation and conclusion answering the problem.

Development should not be confused with research. In development, the end is a product, not an answer to a problem. A product may be developed solely by cut-and-try methods, but frequently research must be employed.

Development men must be practical, ingenious, and resourceful. They should have shop and operating experience and a sense of fitness in producing a salable product. In contrast, research men must be of the analytical type and well grounded in basic ideas, especially in physics and mathematics.

The product of research is an answer to a problem, and this information is represented by the report. This is a valuable piece of company property if correct, but may result in costly errors if it is not.

The pure scientist seeks the absolute truth about the laws of nature and a lifetime may properly be spent on a single problem. A result is never accepted without verification, preferably by different methods. Engineering cannot afford this, but the results of experimental engineering research should be verified whenever possible and periodically reviewed in the light of more recent knowledge and experience. If validity cannot be proved, the reliability of results rests solely on the procedure followed. The elements listed below are procedure requirements:

I Qualified men, organized in a working team.

II Adequate sources of information.

III Suitable physical facilities.

I A working team of qualified men should include:

1 Research engineers, divided into two classes:

(*a*) Technological experts, to assign problems to the staff, guide the work, and judge the results

(*b*) Project engineers, responsible for doing the job.

2 Nonresearch workers, also divided into two classes:

(*c*) Test engineers, working in groups under project engineers (*b*)

(*d*) A general staff, including mechanics, draftsmen, clerks, and assistants of various kinds.

Requirements for research engineers include:

1 An analytical type of mind and training in mathematics, physics, and chemistry. A prodigious memory is not necessary and may be a handicap. An understanding of basic engineering phenomena is a needed qualification.

2 Specialization in at least one field for greatest usefulness. Most necessary technological specialities are thermodynamics, heat transfer, fluid mechanics, mechanics of solid bodies, stress and strain resistance of materials, corrosion resistance, and metallurgy.

3 Previous experience as a test engineer. This is necessary only for experimental research, not for paper research.

II Sources of information can never be too great. Important information may often be obtained from indirect sources and consequently selected reading of seemingly unrelated subjects is desirable and sometimes necessary.

All engineers should know how to use a library. The following are typical or usual sources of information available in libraries:

1 Book references, including engineering handbooks, books on the particular subject involved, and books on related subjects.

2 Reports of societies, institutions, and governmental agencies. Government reports are becoming increasingly important since more than half of the engineering and scientific research in the United States today is at government expense.

3 Company records, properly classified, which should be periodically checked for forgotten information.

4 Professional-society papers, magazines, trade-association publications, industrial bulletins, and catalogs.

5 Patents.

In the use of such published references, engineers should know how to make bibliographies and subject abstracts, and to use other available bibliographies.

III Physical facilities should include a laboratory, with library, calculating and drafting room, stores, and shop equipment within limits. The shop should include instrument-making facilities, preferably in an air-conditioned instrument room, under the supervision of an instrument specialist.

Test engineers are primarily responsible for quality control of

This article comprises notes, reported by George F. Melick and Louise F. Davis, both junior members ASME which were based on a course of lectures given by Dr. Lucke to the Research and Development Department, Worthington Pump and Machinery Corporation, Harrison, N. J., in May and June, 1948.—EDITOR.

the product, which is in reality a phase of inspection. They play a part in experimental research, but testing is not in itself research. The following are functions of the test engineer:

1 To read instruments. This function, which requires but little knowledge, should be assigned to those who can do very little else. Honesty is highly necessary.

2 To record readings of instruments in permanent form. A sense of responsibility for accuracy is needed, and this function may be performed by the same people as (1) above.

3 To correct instrumental errors in readings and evaluate the personal error. This requires more knowledge than the previous two functions.

4 To calibrate instruments. This must be done before and after a test, and while the test is in progress if tests are long. It requires proper facilities, preferably in an instrument room under a qualified specialist. An understanding of the theory behind the instruments is highly desirable, but necessary only for those test engineers who hope to become research engineers.

5 To calculate results from observed data, according to standardized rules whenever possible, and otherwise as directed by research engineers. This requires a knowledge of standardized test codes on instruments and measurements, particularly those of the ASME. Multiple copies of all of these should be available in the library. Test engineers should also have a knowledge of the particular products manufactured by the company and the corresponding trade-association test codes. Where differences exist, a test engineer should know whether they are significant.

6 To design new instruments or connections for simple cases. This is the highest function of test engineers and may be in itself a research project. Just when it is a job for research engineers instead of test engineers depends on the case, and the former should make the decision.

PART I OF THE REPORT

THE STATEMENT OF THE PROBLEM

Research is initiated by a statement of the problem passed down to the research department. The channels followed from the source of the statement to the research department are dependent upon the organization of the particular company. When the research department has received the statement of the problem, the steps listed below are then followed:

1 The problem is discussed with the source to clarify it with respect to the following two factors:

(*a*) The practicability of solving it. This includes discussion as to whether a single answer can be obtained.

(*b*) The usability of the answer by the source.

It should be noted that it is a common occurrence for problems to be poorly and ambiguously stated.

2 The problem is broken down into smaller or subproblems that can stand by themselves. This not only helps to clarify the problem, but may save time by permitting concurrent solution of the subproblems.

3 There should also be an understanding on:

(*a*) The accuracy desired, which should never be greater than absolutely necessary in the interest of economy of time and money expenditure

(*b*) The amount of money to be spent on the solution of the problem. No sum agreed upon can guarantee an answer, since no prediction of the cost and time to achieve a solution can be made at this stage of a research project.

The following are the four types of problems to be met in experimental engineering research.

1 Problems on existing equipment, the answers to which are obtainable by measurements on that apparatus with proper instrumentation. Performance under given operating conditions is an example of this.

2 Problems on existing equipment which cannot be solved by such simple or direct measurements, such as a process or property characteristic, or a relation between variables.

3 Problems requiring apparatus that does not exist. Some phases of power generation with atomic energy are examples of this. Here one must find out how to make the apparatus after a basis for its design has been determined.

4 Problems for which apparatus alone is not sufficient, such as the discovery of a law or property or new engineering principle. This requires the designing of apparatus and tests but considerably more analysis of data.

This concludes Part I of the report, the statement of the problem, which must record a clear understanding of what is to be done in the light of what it is practicable to do and what form and sort of answer to the problem will be usable by the problem source.

PART II OF THE REPORT

ANALYSIS OF THE PROBLEM

The object of this part of the report is to determine the extent to which new effort, especially of the experimental sort, is necessary in solving the problem. This is done by means of literature reference search, calculations, and analysis, and the steps to be taken are the following:

1 If the necessary apparatus exists, procure or have made a description, sketches, and pictures of it. If the apparatus does not exist, a layout of possible types must be made.

2 State the engineering principles or basic theory applicable to the case, whether apparatus exists or not.

3 With this as a background, try to calculate as much as possible of parts or all of the answer, or at least the form of the answer. This defines the residue on which more work must be done.

4 Search the literature for the answer as a whole, or any part of it. Engineers with long experience should be consulted, since only a small part of what has been done in engineering has gotten into print. Sources should be investigated in the order listed, starting with the "book" references.

(*a*) Engineering handbooks, which provide valuable information but cannot always be trusted.

(*b*) Books on the particular subject under consideration.

(*c*) Books on other subjects that may have references to the subject.

(*d*) Papers published by professional societies, institutions, trade societies, and government agencies.

(*e*) Industrial catalogs, advertising, and bulletins.

(*f*) Patents.

Searching should always be done thoroughly, since it is cheaper than experimentation. To facilitate this, professional searchers may be employed to prepare a bibliography or abstracts.

When these four steps have been completed, what is left of the problem must be solved by experimentation.

This completes Part II of the report.

PART III OF THE REPORT

COMPLETION OF THE PRELIMINARY REPORT
THE NECESSARY EXPERIMENTATION

After completion of the first two parts of the preliminary report, the amount of experimentation necessary is known. Before any testing may begin, the following questions concerning measurements and operating conditions must be answered.

1 What quantities need to be measured, and what kind of quantities are they? They may include steady-state quantities, transients, difference between quantities, or a relationship between two or more quantities, such as velocity. If there are differences, will they be measured directly or be determined by subtraction of one measurement from another measurement?

2 What is the probable magnitude and range of variation of the quantities to be measured?

3 Are there any available instruments to measure these quantities, and if there are several such, which one should be selected? If none is available, can a present instrument be modified or a new one designed? It may well be that the whole project must be abandoned at this point for lack of suitable instruments.

4 How will the measured quantities be used to give the desired quantities? What physical constants shall be used, and on whose authority? At this point it is profitable to prepare charts and curves for the calculations involved, to minimize later work while the test is in progress.

5 What operating conditions are to be maintained and how will they be controlled? If they are to be varied, over what range is this variation to take place and how may it be effected?

6 What can be done if the expected operating conditions are not or cannot be maintained? This involves the procedure for correction of measurements for wrong conditions to get the equivalent for right ones, which must be set down at this point. Correction may prove impossible, in which case the operating conditions must be maintained or the project abandoned.

When these questions have been satisfactorily answered, a description and sketches of the setup must be prepared showing the instrumentation so completely that any qualified person can make the complete assembly of what is needed for the observations to be made. Complete working drawings may be necessary in some cases. This material will be part of the permanent record and therefore should be thoroughly understandable. The project engineer for the job should supervise the construction, but he should not physically build it himself.

Log sheets for observed and calculated quantities must then be prepared in both graphical and tabular form. The "master copy" of this log, so marked, is to be signed, dated, and stored in a safe. This original is the only copy which ordinarily may be presented as acceptable evidence in court, and hence has legal value.

This completes the preliminary report which is then submitted to the proper authority in the organization for approval and permission to proceed.

All references used throughout should be listed, giving the exact page numbers.

At this point an estimate of the probable time and cost necessary to complete the project may be made, subject to considerable error. As the testing proceeds this estimate may be made more accurate, but of course its value is correspondingly decreased. In no case should research be hurried; it should be deliberate and thoughtful in every step.

PART IV OF THE REPORT

OBSERVATIONS, CALCULATIONS, AND CONCLUSION

THE ANSWER TO THE PROBLEM

Upon final approval of the preliminary report, which may have required rewriting, an order to proceed and orders to purchase or make necessary material should be issued. If this phase is done correctly, all material will have a common delivery date. If a part or parts cannot be obtained by that time, a substitute should be procured, if at all possible, to avoid waste of laboratory space by delayed completion of assembly. When all the material has been collected, it must be assembled or erected under the direction of the project engineer. Supervision only is required of the project engineer, physical labor or clerical work on his part represent time that he can spend more profitably otherwise.

Workability or operativeness is the primary concern in assembly, a pump that does not pump is worthless. All instruments should be calibrated as they are installed.

When completed, all subassemblies and the entire setup should be photographed for permanent record. Industrial photography is a specialty in itself, since clarity rather than artistic beauty is of prime importance and both shadows and glare must be minimized.

Exploratory operation, not testing, is the next step. Sources of unexpected interruptions must be sought and removed. The expected operating conditions must be checked to see if they can be achieved and maintained for the necessary length of time.

This is the time and place to drill the test crew, but without records. All deficiencies in equipment and of operating-conditions control are then to be corrected, and each change recorded with dated description, drawings, and new photographs. The exploratory operation is then repeated to justify going ahead, or further changes are made. The whole project may be abandoned at this point if satisfactory operation appears impossible.

Actual testing is next undertaken, if all conditions are right. Tabular and graphical data, including the calculated values obtained from the charts previously prepared for the purpose, are recorded on the previously designed log sheets. Each sheet must be dated, signed, and marked "original." These will constitute part of the final "master report" and are not to be used for any further calculations. Working copies must be made to be used in the necessary calculations, and these are labeled as working copies and numbered. They must of course be accurate copies, and "reading back" is the best check on this. The copyist should take no part in this check since he is likely to make the same mistake twice.

Calculations from the recorded data are now necessary, to provide the answer or answers to the problem. This should include an honest estimate of the probable accuracy of the answers. Some results may be reported by a curve or an equation. In the case of curves, all points must be shown and a special technique in plotting, well described in the literature, is required.

Equations should never be reported without specifying the limits of values of the variable for which they are known to be valid.

Finally, a conclusion must be drawn and some sort of reasoned interpretation of the results made, with particular respect to usability.

THE FINAL REPORT

The three parts of the Preliminary Report and the results of the experimentation together comprise the Final Report. These four parts may follow each other in natural succession, or the first part, which is the statement of the problem, may be directly followed by the conclusions reached, the remaining parts being incorporated as an appendix. This latter form is particularly useful for busy executives who rarely have time to do more than "skim" a report for the pertinent information.

The master copy of the report should be bound, stored in a safe, and never handled without authority of executives, or when necessary for use as evidence. Additional copies, which should be numbered, may be made for distribution. A record of who has these various copies is advisable, preferably on each copy, so that everyone having a copy knows who else has one.

How GAS TURBINES *Fit Into* FUTURE POWER PATTERNS

By S. A. TUCKER[1]

THE gas turbine, as we know it today, is much more than another power producer. It is an entirely new means of pressure-conversion, waste-recovery, heat-exchanger, or propulsion unit. For each application it presents different characteristics and different advantages. It is compact for locomotives—no water, low maintenance. It means more power for ships of certain classes. It drives airplanes faster than any other practical means. As a power plant, it is complete within itself, without major auxiliaries and is free from geographical limitations. For process industries, it is a compressor or expander, a waste saver, or heat absorber. The gas turbine has only begun the first stages of its advance toward becoming the jack-of-all-trades among prime movers.

PRESENT STATUS OF GAS TURBINE

This paper owes its existence to a question asked of the author with clocklike regularity. With some variations in wording it goes like this: "When will the gas turbine really become a competitor of other prime movers, the steam turbine and the Diesel engine?"

A basic answer to this question would be simple if that answer did not immediately breed a half dozen offshoot questions in the asker's mind. In one sense the gas turbine will not ever compete directly with other prime movers because it offers an entirely different set of characteristics and advantages. Almost every application so far achieved or contemplated has been based on some specific need that a gas turbine can fill to better advantage than a steam, gasoline, or Diesel engine. The Houdry machines, acting as superchargers, the jet-propulsion units for aircraft, the Velox-boiler charging sets and stand-by units for desert service are examples of this difference.

IMMEDIATE PROSPECTS

It is easy to proceed a little way into the future as specific needs are concerned. A gas-turbine locomotive should ride American rails in 1948, more in 1949. A ship-propulsion unit is ready for trials. We will soon have operating data on several types of power units from Rumania, Switzerland, Peru, and Egypt. There will be more data applying to power generation available from Schenectady and South Philadelphia as days go on.

We have reviewed before, and can again, the practical and economic advantages of gas-turbine locomotives, ships, and power units. Wherever oil or gas is a normal fuel, and for sizes between 2000 hp and 30,000 kw, gas turbines can compete with steam or Diesel on their own home grounds.

But, as has been said before and should be said again, the compelling factor has been the ability of the gas turbine to meet needs not well handled by other prime movers. The classic example is that of aviation—one can fly faster with a gas turbine than any other heat engine. It is not a matter of dollars and cents, metal limitations, or fuel. It only matters to the Air Force that speed is the one controlling objective.

One must not forget that the gas turbine as we know it today came into existence as a gigantic supercharger for the Velox boiler. The fact that such supercharging sets have a small net surplus of power is minor. The major item remains that the Velox boiler would be completely impractical without a gas turbine auxiliary set.

We must remember too, that locomotive and stand-by power-unit development proceeded very slowly indeed until the requirements of the Houdry catalytic refinery process demanded just such a supercharger as suited the Velox boiler. Aviation development would have gone nowhere if gas turbines had not naturally been adapted to jet propulsion.

BY-PRODUCT CHARACTERISTICS

Thus the gas turbine has been sold against other devices by virtue of its by-products. The assembly of parts we know as a gas turbine has the characteristic of inhaling lots more air than other heat engines and exhausting a lot more "flue" gas. Because of this characteristic it can be nearly self-cooling, or air-cooled, a difficult proposition with other heat engines. Also, being a rotating, rather than reciprocating, unit, a gas turbine becomes naturally compact—high power in small space.

These two items tempt railroad men. Getting 6000 to 8000 hp into a road locomotive using Diesels means several cabs, and steam is not a happy answer. Experience with Diesel power plants for locomotives, and indeed, the conventional steam "iron horse" leads any railroad man to hope that the calculated performance of gas-turbine locomotives, backed up by the relatively meager experience with one Swiss unit, might prove a solution to the high-power high-speed road locomotive of the future. I wish I could be a salesman for just a few days—with a few dozen 6000-hp gas-turbine locomotives ready for immediate delivery.

DEVELOPMENT STAGES

To go back into history, at Tulsa in 1944, I said "For the immediate future the question that must be answered is: Who will first be ready to invest money in what may be regarded at best as an experimental unit? The railroads, maritime operators, the steel industry, and power people all have a stake in the further development of gas turbines."[2] We have long since seen this question answered with a great degree of sound sense. Both the Army and Navy realized the importance of accelerated research and development. They worked not only through the medium of established aviation-engine companies, they used nearly every major tubine manufacturer as well.

It is from the work of General Electric, Westinghouse, and Allis-Chalmers in the aviation field that basic foundations for power units have already come. Principles, materials, and manufacturing know-how have developed from the aviation

[1] Formerly Managing Editor, *Electrical World*, New York, N. Y. Since this paper was presented Mr. Tucker has joined the staff of the ASME as Standards Manager.

Contributed by the Gas Turbine Power Division and presented at the Spring Meeting, New Orleans, La., March 1–4, 1948, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

[2] "Gas Turbines: Present Status and Future Prospects," by S. A. Tucker, MECHANICAL ENGINEERING, vol. 66, 1944, p. 364.

(*Continued on page 802*)

Glimpse of ENGINEERING *in* INDUSTRY

By T. A. BOYD

RESEARCH LABORATORIES DIVISION, GENERAL MOTORS CORPORATION, DETROIT, MICH.

SINCE I began my professional career back in 1918, many, many improvements have been made in the automobile of course. Also, thanks to the efforts of the research man and the engineer and to the faith and enterprise of American industry, a multitude of advances have been made during that period in other fields. Radio is one of those new things; and radio is bringing, even into the most remote places, music, drama, and world events, as well as singing commercials, soap operas, and blood-and-thunder thrillers. Nowadays radio is beginning to be supplemented further by television of course. Since 1918, the motion picture has learned to talk, and many films are dressed in color as well. Hard-surface highways, of which there were not many in 1918, now spread like a net over the whole nation, and the cars running on them all the way from coast to coast have increased fivefold in number. Within the same period aviation has become an industry, and it has grown until airlines and airports now cover the nation and the world. Synthetic rubber and synthetic textiles of different kinds have come into being, so that for one thing the cotton stocking has been displaced almost completely by nylon hose. We have fluorescent lighting, frozen foods, and color photography, even for the amateur. In the important field of medicine, we have insulin, sulfa drugs, penicillin, streptomycin, and other marvelous lifesaving remedies. So many advances have been made in recent years that a man in middle life today has seen more changes than were made in several lifetimes in the past.

Here seems a good place to say also that this amazing parade of progress has not ended by any means. It is moving right ahead still, and today's engineering students are going to have an important part in it. Their job will be to pick up a few of the problems in science and industry and to help solve them. They will have ample opportunity for doing so, for the truth is that the progress made up to now, great as it is, is really mighty small by comparison with what is still waiting to be made. Charles F. Kettering, who last year retired as head of our Research Laboratories Division after nearly 30 years in the job, to be succeeded by Charles L. McCuen, has said this: "We have only begun to knock a few chips from the great quarry of knowledge that has been given us to dig out and use. We know almost nothing about everything. That is why, with all conviction, I say that the future is boundless."

The size of the contribution to progress which future engineers succeed in making will be determined in part by their ingenuity of course, but still more by the amount of work they do. There must be a willingness and determination to work, and to work hard. Thomas A. Edison, who should have known, said, "Hard work and forever sticking to a thing until it's done are the main things an inventor needs." Edison was more epigrammatic when, on another occasion, he said that "Genius is one per cent inspiration and ninety-nine per cent perspiration."

On this same point Mr. Kettering also has said the following: "Among the many qualifications of the inventor or researcher, is that he should not bruise easily. This is because a research worker is almost always meeting failure and rebuff, and he must not be discouraged by either. There are two kinds of courage. One is a spontaneous explosion of aroused instincts to meet some sudden emergency. The other is steadfast and enduring against repeated failures and rebuffs. It's what boxers call 'the fighting heart'—the will to come bouncing back every time one is knocked down. All pioneers need that kind of courage. It is the 'follow-through' that makes the great difference between failure and ultimate success, because it is so easy to stop. So the only time you don't want to fail is the last time you try."

To go back now to the automobile, there is nothing I can say that could possibly give an adequate impression of how greatly the motorcar has been improved over the years. Such an understanding can really come only from direct comparison—from seeing the two cars together and from driving them side by side. Such a direct comparison would show that the present-day car is a great deal easier and more pleasant to drive; that it has much better performance and speed characteristics; that it is quieter, smoother, and more comfortable to ride in; and that it is so dependable and so automatic in operation as to be driven successfully by people with no understanding whatever of its working mechanism.

The great improvement in the motorcar over the years has come because of intensive engineering and research effort and because of the custom of the yearly model. The importance of the yearly model is that it has provided an opportunity for changes to be made frequently, which, in a mass-production industry like ours, otherwise, would have been difficult. Thus the yearly model has made it possible to change by evolution rather than by revolution, and that is an accepted American way of making progress. Every car-making company has had a staff of engineers to solve problems in the car currently being manufactured, and to make improvements in the next model. In addition, research laboratories, as well as product-study and process-development groups, have been established, which have been concerned chiefly with improvements on a longer-range basis. These latter are the "finder-outers," and the engineers in the actual car-making company are more the "getter-doners," although they find out new things too. There is also co-operative effort between the various groups, in which the commercial background of the one and the specialized abilities of the other combine to yield a solution that is commercially sound. In General Motors the total of workers in these groups is more than 2000, divided about equally between technical personnel and those mechanics, testers, and the like, who assist the technical men.

In addition to all these, there are those many, many men—engineers, metallurgists, chemists, and physicists—who work in the several industries which serve as suppliers to automobile makers, including (*a*) accessories, such as spark plugs, ignition systems, carburetors, and tires; (*b*) materials of construction.

Address presented to engineering students in eight West Coast Universities, May, 1948.

Just how many engineers and other technical men contribute to the automobile through such materials as steel and other metals, and as finishes, safety glass, and rubber is not known, but it is quite large, of course.

AN INSTANCE OF HOW MAJOR ENGINEERING IMPROVEMENTS ARE MADE

In the first car purchased by our family back in the 1920's, one of the most annoying and unsatisfactory features of all was the roughness of the ride, particularly in the back seat. When driving over a bump or on a wavy road, the stiff leaf springs at the front with their short deflection moved the front end of the car up and down faster than the softer and longer-traveling rear springs moved the back end. This caused the back of the car to have a pitching as well as a bouncing motion. In the back seat the tossing was so bad that some people simply would not ride back there.

And so the correction, during the 1930's, of the rough riding quality, which was such a serious shortcoming of cars up to that time, was a major improvement in the automobile. A little story of how it was done will serve as a kind of case history illustrating the way major engineering advances are made in our industry.

Before these improvements were made, the longitudinal leaf springs at the front of the car were attached to the axle. The springs in the front were made stiffer than those in the rear because they had to do double duty. They functioned not only as springs for the front part of the car, they served also as structural members to hold the front axle in place against the large forces and the violent shocks it has to absorb.

Such a major engineering endeavor as producing an altogether new system of front-end suspension was naturally not a change that could be made between one yearly model and the next. It took some years of effort, in fact. One of the several things done during the course of the investigation was to make laboratory measurements of comfort, using human subjects seated on a specially designed "bouncing table," from which was derived a "curve of comfort" in terms of frequency and displacement of up-and-down movement. An extensive road study of weight distribution was made in which a car was utilized, which was fitted with outriggers to which a variable number of heavy cast-iron weights could be clamped. By this means, the whole range of possibilities in weight distribution, moment of inertia, and spring deflections, could be explored, and likely combinations could be checked over and over again. The two endeavors just mentioned came in the early or research phase of the endeavor of course, when the problem was being evaluated and narrowed down by seeking essential information.

Out of all their studies and tests, the investigators came at last to the conclusion that the arrangement which promised to fill the requirements best was a system consisting of a coil spring for each front wheel, held in place by hinged members of wishbone shape. That arrangement eliminated the rigid front axle and allowed each wheel to move up and down independently of the other. It permitted the front spring rate to be made the same as the rear; it permitted one front wheel to rise over a bump in the road without affecting the other; and, because it did not serve as structural support for other parts of the car, it divorced the steering from the springing. The modified springing, as applied, called for a new frame design, an entirely new steering arrangement, new shock absorbers, and a shifting forward in engine location to give better weight distribution.

Then came road tests of cars fitted with the new suspension. The cars were driven many thousands of miles over wavy roads, over rough Belgian block pavement, over gravel roads, and over mud roads, under all conditions of weather. Afterward, the parts were disassembled and inspected for wear or for failure of any kind. Changes so indicated were then made, and the program was continued until the most satisfactory combination of factors was attained.

In one part of the program, lights were attached at a point over the rear fenders of a car with the new front-end springing and also of a car with the old-type leaf springs. Photographs of each car were then taken from the side as it was driven at night. The traces made on the film by the lights showed the great difference between the behaviors of the two cars when each passed over a bump in the road. In the case of the car with the old system of springing, the curve of rear-end motion had a jagged appearance which came from a combination of pitch and bounce. By contrast, the car fitted with the new suspension gave a light trace that was smooth and uniform.

This is a partial story of how one important engineering advance in cars was made. The value and importance of the new springing, as thus developed, is attested by the circumstance that the major portion of all the cars built in the several years since it was developed have been fitted with such an arrangement of front-wheel suspension.

In this, as in so many products of research, the customer is the one who benefits most. In the years since the improved front-end springing was put on cars, millions of riders have been saved the uncomfortable pitching and bouncing which formerly accompanied riding over bumpy or wavy roads.

THE LONG BATTLE AGAINST KNOCK

A different kind of investigation is that of the long battle against knock. Knock, as is well known, is that annoying engine noise which, because it gets worse as cylinder pressure goes up, keeps the compression ratio of the automobile engine from being made as high as would be desirable. The most recent event in the investigation was the building in our laboratory of an automobile engine of very high compression. The compression ratio is more than 12:1, just about double that of present-day automobile engines. The construction and operation of this experimental engine was made possible by knowledge gained through years of prior engineering effort and by the availability of a gasoline free enough from knock upon which to run it. The new engine gives a third more miles per gallon than a present-day engine of like performance. Such a large gain in economy, if it could be attained in practice, would be very much worth while, particularly in times like these, when there is a shortage of gasoline supply.

The knock-free fuel required, as well as the know-how to design and build a satisfactory engine of such a high compression, did not come overnight. The availability of the fuel is based on research extending back a long, long time—more than 30 years, in fact. The man who first appreciated that the noisy bugbear of knock is the great shortcoming of gasoline, and who tried to do something about it, was Charles F. Kettering. Back about 1916 Mr. Kettering set out to study knock and to see what might be done to eliminate it.

To make a short story out of what was in reality a long, long one, and one filled with a great deal of tedious toil and many discouragements, it may be said simply that of the several discoveries which came out of that investigation two were of outstanding importance. The first was the chemical antiknock agents, of which tetraethyl lead proved to be best. Tetraethyl lead is a liquid—found after a long, long search—which, when added to gasoline in minute amounts, cuts down its tendency to knock to a large degree. After much experimentation with tetraethyl lead as an antiknock agent in automobile engines, it was modified by the addition of some other materials to make its use in gasoline practical. It has since

been employed to boost the antiknock quality of nearly 500 billion gallons of gasoline, both for automobile engines and aviation engines.

The second of the two important discoveries was that the knocking properties of the gasoline itself are determined by the architecture of the hydrocarbons contained in it. The worst possible hydrocarbons for giving knock-free power are those in which the carbon atoms have the straight chain grouping. Unfortunately, those are the very kind which occur in petroleum for the most part. It was found also that the hydrocarbons freest from knock are those with the carbon atoms closely compacted.

These items of knowledge were promptly made available to everybody, stimulating extensive researches on how to make gasoline containing hydrocarbons of more knock-free types. This phase of the work was done chiefly within the petroleum industry. The fullest advantage of the know-how thus obtained was taken in producing the high-output aviation gasoline which was such a great factor in winning the war. Without the knowledge of hydrocarbons and without tetraethyl lead, both of which came out of the research mentioned, we could not have had the 100-octane aviation gasoline which gave our pilots such a big advantage over the enemy with his inferior fuel. "I think we wouldn't have won the Battle of Britain without 100 octane," said Geoffrey Lloyd, Great Britain's wartime petroleum secretary. This, by the way, is a striking instance of how technical developments made in peacetime often prove indispensable when war comes.

The effect of the two discoveries mentioned in the important field of the automobile was that, during the decade 1930 to 1940, the average octane number of regular-grade gasoline went up from only 60 to nearly 75. At the end of the 10-year period, regular-grade gasoline was freer from knock than premium gasoline had been back at the beginning of the decade. During that same period, automobile makers on their part took advantage of the better gasoline as it came along to boost the compression of engines. Compression was raised gradually from a ratio of only 4.5 on the average to about 6.

The improvement in automobile engines thus brought about was in part an increase in the performance factor, so highly prized by American drivers, and in part a simultaneous increase in the economy factor, as measured by ton-miles per gallon. During the years 1930 to 1940, performance at 50 mph (measured as bmep × cu ft displacement per ton-mile) was boosted about 25 per cent on the average. The improvement in fuel economy over the same decade was on the average from 28 to 38 ton-miles per gallon, or an increase of more than 30 per cent. This comparison is made in ton-miles per gallon in order to compensate for the increase in car weight which occurred meanwhile. Thus by appropriate changes in cars, based in part upon the better gasolines and in part upon refinements in design, the automobile engineer has made substantial increases both in performance and in miles per gallon.

Referring again to the experimental high-compression engine recently built in our laboratory, it gave an increase of a third or more in miles per gallon over the present-day car of the same weight. This boost in economy was obtained without any sacrifice in car performance or in engine smoothness. That increase is thus the further gain in miles per gallon that can be obtained, whenever fuels good enough in freedom from knock to run such high-compression engines are to be had. Our industry has developed engines capable of getting these gains. Therefore, we are anxious to have available in filling stations, just as soon as possible, the more nearly knock-free fuels which will make it practicable to use more economical engines of higher compression ratios.

The importance of this development, when it can be utilized, is that to the car owner it will mean up to a third more miles per gallon. By sending drivers to the filling station less frequently, it will thus conserve our valuable reserves of petroleum. It is a good way to find the equivalent of more oil wells. The only further thing needed to make possible the utilization of this advance is a gasoline of higher octane number.

DIESEL POWER ON THE RAILROADS

New products grow slowly from seed like plants. The seed for the Diesel-powered locomotive of today was planted a long, long time ago. And the story of the growth of that important product is perhaps interesting enough to be related here as another case history in engineering and research.

Rudolph Diesel invented his engine in 1892, over 50 years ago. To trace the seed from which the Diesel engine grew it is necessary to go much further back, hundreds of years, in fact, and clear around to the other side of the world, to far away Samoa. There, fires were kindled not by the old friction method used today by boy scouts, nor by that other aboriginal method of striking a spark off a flint. The Polynesians started fires by compressing air. A wooden plunger was fitted into a hollow section of bamboo, arranged like a popgun, except that it was closed at one end. On the end of the plunger was put a little piece of dry moss. When that plunger was forced quickly into the bamboo cylinder, the air was heated hot enough by the compression to set the moss on fire. This is how for centuries fires have been kindled in Samoa.

You would not think of the popgun as the ancestor of the Diesel engine perhaps. But it was pretty nearly that nevertheless. For it was when Rudolph Diesel saw in a German museum one of those Polynesian fire sticks that there came to him the idea of making an engine to operate on that same principle of ignition by compression. So he built an engine to compress air quickly to a high pressure, and then to inject the fuel into that very hot dense air.

The compression-ignition engine, thus invented by Rudolph Diesel, came slowly into use, but only very, very slowly. This was in part because the Diesel engine was put to work mostly in ships where it was substituted for steam engines which had turned only 100 or 125 rpm. So in replacing the steam engine for such service, the Diesel became a large slow-speed engine. Later there was an attempt to build Diesel engines like gasoline engines to put into trucks and buses. But still there was no Diesel engine which was at once light enough and powerful enough to be really suitable for use in railroad locomotives.

Mr. Kettering had long been interested in the Diesel engine and in finding out why it was not more successful and more useful. So, along in the 1920's, he began experimentation in the Diesel-engine field. It soon became apparent that there were two principal problems in the Diesel engine. The first related to the means of injecting the fuel into the cylinders, and the second to the very high weight of the engine per horsepower, which in some Diesel engines was as much as 250 lb. It was observed that, in existing systems for injecting fuel, pump pressures were too low to atomize it into as fine a fog as was needed for good combustion, and also that the pressure pump was too far away from the injection nozzle. As the long column of fuel oil in the pipe between the pump and the injection nozzle was elastic, its springiness interfered with sharp cutoff at the injection nozzle and so with good control of metering. This spoiled the flexibility of the engine—or its ability to be operated over a satisfactory range of speed and load.

Both these injection problems were at last solved by the development of the unit injector. In that system the pressure pump was made a part of the injector itself and put right at the

nozzle for each cylinder. This combined pump and injector was arranged to force the fuel into the cylinder at pressures as high as 20 to 30 thousand pounds, about 4 times as high as had been used before. Of the many problems met in the development of the unit injector, one was this: To do what was required of it, the pump piston of the injector has to be fitted into its cylinder with a clearance measured in millionths of an inch. That, said the production people, was simply not possible. But nevertheless by experimentation a way was found to do it which was so practical that the injectors were soon being made at the rate of some thousands per day.

It was in the effort to solve the problem of large weight per horsepower that the 2-cycle principle was adopted. The 2-cycle engine gives twice as many power pulses per cylinder as the conventional 4-cycle. The goal was a Diesel engine, weighing no more than the gasoline engine of equivalent power, and having the same ability to operate satisfactorily over a wide range in speed and load. The engine was developed not on paper nor through theory at all, but by a long series of cut-and-try tests designed to ask the engine itself just what it would like to be. To do that took some years of intensive experimental effort to be sure; but, as experience has shown, the engine did give dependable answers to the design questions put to it.

One of the principal problems in the 2-cycle engine was that old Diesel-engine difficulty of pistons and piston rings—how to make them last under the severe service to which they were subjected. After much experimentation, that difficulty was overcome by using pistons of iron instead of aluminum, cooling the piston head with a jet of oil, and inserting a "heat dam" or thin section between the piston head and the ring belt to keep the heat of the piston head from running down to the rings.

The effect of these improvements has been that the life of pistons and piston rings, which always before had been very short, is now in railroad service as much as 500,000 miles or more for piston rings, and over a million miles for pistons. Not all this improvement was gained at once nor without an immense amount of toil and trouble. At our place we have a motto which says that "the price of progress is trouble."

In 1933, at the Century of Progress Exposition in Chicago, two of the 2-cycle Diesel engines, embodying the best knowledge up to that time, were installed there to run generators and furnish light and power for the General Motors exhibit. Those trials were in actuality a part of the development program, for that phase of the effort was still far from being completed. The two Diesel engines running there were seen by men from one of the western railroads who wanted a small streamlined passenger train. Having no suitable power plant—no engine with sufficient power that was light enough—they asked to purchase one of those engines or another like them to power that train. One such Diesel engine of 600 hp with suitable electric generators and motors was installed in the lead car of that train as they had requested. The year was 1934 and the train was named the Burlington *Pioneer Zephyr*.

That little train was such a novelty and it had so much advertising potential that the Burlington people sent it around the country on a demonstration tour, during which it was viewed by millions of people. During that period an event occurred which fixed the future course of the development.

The event was a conversation between Mr. Kettering and H. L. Hamilton. Mr. Hamilton was then president of the Electro-Motive Corporation, a small division of General Motors which for about ten years had been building engine-powered electric-driven railway cars using spark-plug engines burning gasoline or distillate. Out of the conversation came the conclusion that the small train with a 600-hp locomotive was not the right way to use Diesel power in railroad passenger service. The men concluded that a Diesel-electric locomotive ought to be built that would pull trains of full size, and trains made up in whole or in part of present cars, if need be.

"Such a locomotive would be costly by comparison with the steam locomotive," Mr. Hamilton said.

"I don't know just how much it would cost," Mr. Kettering replied, "but I'll guess $500,000 or more. And if you are willing to build such a locomotive, with, say, 3600 hp of Diesel engines, or whatever is needed, I'll go to Mr. Alfred P. Sloan, Jr., and try to get the money to build it." Mr. Sloan was then president of General Motors.

The outcome was that the money was made available to the Electro-Motive Division of the corporation, which at that time was a very small concern indeed. The locomotive, designed by the Electro-Motive organization on the basis of such small experience as they had had up to that time, was then built on contract by the General Electric Company in its locomotive shop at Erie, Pa. In that first full-scale Diesel-powered locomotive, the Diesel engines and the electric drive were contained in two cars built like conventional cars, without any attempt at streamlining.

When completed, the plan was to loan that locomotive to the railroads for demonstration and trial. But word got around that it was being built. So great was the interest in the Diesel-powered locomotive by that time that, before the sample was finished, each of two railroads had ordered similar full-power units for their service, altogether sight unseen.

This is how the highly successful Diesel-electric locomotive came into being. Through it the powering of American railroads is being revolutionized completely, for the Diesel locomotive has been so successful in respect to dependability, constant availability, economy of operation, and high starting tractive effort, that almost all the locomotives now being built for the American railroads are Diesel-powered.

For some time the Diesel locomotive was built for passenger trains only, except switchers. But in 1941 the manufacture of Diesel freight locomotives also was begun. In that service the Diesel engine has proved just as successful as in the passenger field. In the first ten years of the Diesel locomotive, over 1750 units were build for 80 railroads. Last year over 90 per cent of all railroad locomotives built were Diesel.

If it had not been for the existence of three vital factors of industrial progress, the great advance represented by the Diesel railroad locomotive would not have been made. The three factors were as follows:

1 An idea backed by the faith of someone.

2 An aggressive program of research and development to produce a successful sample.

3 The business courage to back the new enterprise financially to the point of commercial success

YOUR 1975 MODEL—I'D LIKE TO DRIVE IT

At this point I should like to return to the automobile long enough to say that, although the motorcar has been marvelously improved in past years, it is still far from being so perfect that nothing is left for the men of the coming generation to do. Only to the man who is shy on imagination, is anything ever really perfect. Our present models, fine as they are, are really only the jalopies of tomorrow. To be sure, we do not have enough imagination today to say just what the improvements will be that will be made. If we had that much imagination—and knowledge—we might as well go ahead and make these improvements ourselves.

One can surely imagine still better and lighter engines, and

engines giving a great many more miles per gallon than those we have today. Now, only 10 to 15 per cent of the heat of the fuel on the average is converted into push for the car. When at present it takes a 4000-lb assembly of steel, rubber, and glass to haul one person sometimes, we might even imagine lighter cars. Cheaper and more plentiful light metals, for one thing, could help some in this regard. We might imagine a steel that would not rust and that would be cheap enough to use for fenders and bodies. We might imagine a car still more completely automatic in operation. We might imagine a more glare-free lighting system for night driving. And we might imagine many other things. The coming engineers will do that for themselves at the proper time. As for me, I should surely like to be around to drive their 1975 model, and to drive it on the better highways which will have been built by that time.

WHAT EMPLOYERS OF ENGINEERING TALENT WANT

The nature of the business in which General Motors is engaged is such that we have need for more men trained in mechanical engineering and electrical engineering than in other branches. Nevertheless, among the 300 or so new technical men employed each year, there are men in all branches of engineering.

While I am not in any sense recruiting men, it might be of interest to say a word about the policies of our organization in respect to engineering employees. The corporation recognizes a responsibility to its employees and believes that its own continued success depends upon the caliber of the men hired in junior engineering positions. They are the men who will fill the important jobs in the future, for it is a major policy of the organization to promote from within. Because of this policy, most of the present executives of the corporation have risen from the ranks. Many of our highest executives, including the chairman of the board and the president, are engineers.

Here are a few of the operating principles, as laid down by Corporation policies:

1 Put the right people in the right places.
2 Train everyone for the job to be done.
3 Make the organization a co-ordinated team.
4 Supply the right tools and the right conditions.
5 Give security with opportunity, incentive, and recognition.

Now the question of just what qualities the employer looks for in the men he hires is a difficult one to answer. There is in reality no single or simple answer to it. This is because the demands of employers in industry differ considerably from one employer to another. That is perhaps a lucky thing for the college-trained man, because college men have surely not all been poured into one common mold.

In blood transfusion, it is essential that the blood of the donor be of the same type as that of the patient. Just so the employer, when infusing new blood into his organization, looks for men with those qualities which suit his own particular temperament or conditions. Paul de Kruif has told how, when Ronald Ross in India was looking for an assistant to help him in his search for the malaria microbe, he hired Mahomed Bux, because, said Ross, "he had the appearance of a scoundrel, and scoundrels are much more likely to be intelligent." But, at least among employers of engineers, Ross's rule is not looked upon with favor. They want men with intelligence, to be sure, but they want them as well to be intellectually honest in the strictest sense of the word.

Employers in engineering and research laboratories want the college-trained men to have knowledge, of course. However, they do not care particularly about mere encyclopedic knowledge, for that is usually not worth much. A good encyclopedia can be bought for a hundred dollars, you know. What they do care about is knowledge of the fundamental principles of essential subjects, of how to muster the scattered information that is available, and of how then to bring it to bear upon the particular problem in hand. This demands the ability to think independently, which faculty is another one of those that employers want the college-trained man to have.

The engineering school is a good place to acquire both knowledge and the ability to think. It is, however, a matter of experience that not everyone who goes through the university gets out of it just what he is supposed to. Former President Lowell of Harvard said once: "No wonder there is so much knowledge in colleges. The freshmen always bring in a lot, and the seniors never take any away with them." The employer is looking particularly for the fellow who realizes that his college training is only a foundation upon which the real structure of his knowledge and experience has to be built in later years. So it is of the highest importance that the foundation laid in college be just as broad and as firm as possible.

Employers in engineering and research laboratories want the man who is good at getting new knowledge, which means that he must know and be able to use the so-called scientific method, which is the basis of all research. So also they want him to be a good experimenter and a minute and accurate observer. They want, if possible, to avoid the fellow who reaches conclusions from insubstantial evidence. They want the man who has imagination, resourcefulness, and initiative—who is something of a self-starter, and who does not depend upon the boss to furnish all the ideas, for the boss's ideas are usually not as extensive as he would like. They want the fellow who looks for reasons why a thing can be done rather than for reasons why it cannot be done.

The employer of engineering talent wants the man who has learned how to work, who is willing to work hard, and who has enthusiasm for his job. He wants him to be able to cooperate with others, to get along with whatever kind of workers he may have to come in contact with, and to make a good impression wherever he goes. Prima donnas are usually not very useful in an engineering or research laboratory, nor anywhere else in industry. And then he wants him to have good health and good sense—that sort of good sound sense which is sometimes called common sense, although the possession of it is not nearly as common as it might be.

The man who employs engineers wants also the fellow who can say things accurately and well, and who can write reports that are easy to read and readily understood. He is looking for the man who is free from that common lack of expressiveness which made Mark Twain speak of us as "those ponderous scientific people." This is a true story of a young chemical researcher who was let out by an exasperated employer because he could not make head nor tail of his reports. Afterward a friend of the inarticulate young fellow, out of the goodness of his heart, spent a lot of time writing a "translation" of his last report, putting into plain English what he had tried to say. That account was published and it chanced to come to the desk of the very executive who had ordered the dismissal of the young man. The busy executive, not recognizing the name of his former employee, marked the paper for the attention of his research director with this note: "We could use a man like this."

A great deal has been said and written about how to apply for a job, how to write letters of application, how to conduct one's self at personal interviews, etc. All that is important—it is very important. But, students in engineering colleges should know about another thing which, for anyone who expects to go into engineering or research in industry, is even

more important still; that is to establish with those men who are his teachers in the university a reputation for having a good measure of the qualities just enumerated. This means that in some way he must actually acquire the qualities named, such as intellectual honesty, initiative, enthusiasm, versatility, and knowledge of the important fundamentals in science and engineering. The reason why this is of such paramount importance in the case of the man going out of school into his first job is of course that any prospective employer will surely ask the advice of the men in the college, and their opinions are always given large weight.

"ACCENT ON YOUTH"

It will be of special interest to embryo engineers that invention and research are in major part a young man's game. That this is so, and that it is true also of other creative endeavors, has been known in a general way. But recently the late Thomas Midgley, Jr., tried to put the observation on a more quantitative basis. From the records of the U. S. Patent Office he compiled a table of important inventions, including the age of each inventor at the time when his patent was issued. From those figures he plotted a curve which showed that the peak of inventiveness comes at age 35, and that most of the inventions were made between the ages of 25 and 45. That is one of the reasons why we try so hard to keep infusing new blood into our engineering and research organizations. Conversely, the period between the ages of 25 and 45 is going to be the time when the coming engineer will have his greatest opportunity to contribute in a creative way to the industry he elects to enter.

CONCLUSION

In conclusion, mention may be made of the circumstance that the usefulness of the simple technique of finding the facts first and then facing 'em, which is the principle of research, is not limited to the field of technology at all. "It is just as important," said Alfred P. Sloan, Jr., "to apply research to all the functional activities of a business as it is to the technological phases of the enterprise." Fact is that in modern business the executive who decides questions merely by the old system of snap judgment cannot long survive—or else it is the business that does not survive. The very same technique can be useful to a fellow in his own everyday affairs also.

Inventions too can be and are made in fields other than engineering and technology. One of the greatest of these inventions, as has been pointed out by the president of our corporation, C. E. Wilson, is a political one—the American Constitution. "For more than 150 years," thanks to that great invention, "free men here in America have had the opportunity to educate themselves, select their own occupations, accumulate capital and invent better ways of doing things. This is why the people in the United States are so much better off than the people in the rest of the world. This is why our standard of living is about nine times as high as that of the people of the rest of the world."[1]

It is to insure the continuance of this progress that, in the words of Mr. Kettering, "American industry is cultivating ideas and men as its richest investment in the future. We are looking for young Marconis, young Bells, young Edisons. We have many of them in our laboratories now. We encourage them. If we give them the opportunity of free enterprise, they will contribute freely. In every industry, those existing and those to come, their improvements will demonstrate clearly that what we have today is not enough, and is not good enough."

[1] Quoted from "The Great Delusion—Where Marx Went Wrong," by C. E. Wilson, MECHANICAL ENGINEERING, vol. 69, 1947, p. 658.

How Gas Turbines Fit Into Future Power Patterns

(*Continued from page 796*)

program that will benefit the heavier types of machine for power units.

In 1944 also, I said "From the long-run viewpoint, it would be most desirable for all concerned if the first machine were to be a power unit for installation on the electric lines of some utility company where the best of engineering and operation could be assured unhampered by the extraneous problems invariably associated with transportation and shipping." To this suggestion there has come an answer beyond anyone's fondest expectations. Both the steam turbine and the Diesel engine were tested and proved in the plants of the purchaser. The gas turbine is being right now tested and proved in the plants of the *manufacturer* and with the latter's money, men, and facilities!

To a power man this situation borders on the fantastic. That a manufacturer should run so expensive a machine as the Westinghouse 2000-hp open-cycle unit to destruction is certainly novel. Neither General Electric nor Westinghouse have, or want for that matter, customers for their full-size, costly, first units.[3] (Note that there is no such thing as a "model," "prototype," or "test" gas-turbine unit. One either builds the whole works or nothing.)

Practically every manufacturing representative to whom I talk informally, engineers, designers, salesmen, and even public-relations representatives, worries at one time or another that the materials for gas turbines cost so much that the resulting units may be difficult to sell. One can have as much fun with this debate as from a good football game—providing he is a spectator and in no danger of losing large areas of skin.

Enjoying the freedom of one who wins if right, and tarnishes his reputation only as a speculator if he loses, I hasten to assure all and sundry concerned that economic forces far stronger than those of straight competition with steam turbines or Diesel engines are hard at work. Those who buy gas turbines in the next ten years will demand units of specific requirement with little real concern about price. Someday, we can hope, manufacturing costs will be stabilized with the cost of gas turbines not out of competitive range.

An interesting, if not wholly logical, way of illustrating this point would be to consider the history of the domestic refrigerator as distinct from the original "ice-box." Even within my brief memory, I have listened to sage economic arguments that people just would not pay $300 for a device that was so obviously a luxury while "the same service could be had for $40 and a few cents a day for ice." Folly. People bought refrigerators because mechanical refrigeration did a better job than the ice-box.

Then ingenious thought in the application developed new functions for what had seemed to be a finished device. One could make ice cream, for example. Milk can be delivered every second day—twice a week if necessary. Ice comes in cubes without ice pick. Even quick freeze and frozen storage can be had.

Just as mechanical refrigeration has revolutionized the handling of food within the home, so the gas turbine, as a more versatile means of converting heat into various forms of what the professors call work (mechanical, electrical, air pressure) is about to make far-reaching changes in the pattern of process industries and power. The gas turbine can and most assuredly will do this because it offers another and more versatile means of doing the power job.

[3] G.E. has since sold two 3500-kw power units.

LABOR RELATIONS *in a* NUTSHELL

By ALFONS PUISHES[1]

COUNSELOR AT LAW, CLIFTON, S. I., N. Y. JUNIOR MEMBER ASME

IN these troubled times on the industrial front, poor John Q. Citizen not only has to bear the brunt of most of the trouble but much of the time is at a loss to understand what is going on. Paying the bills is bad enough but not knowing what you are paying for borders on the tragic. And no wonder! Such esoteric terms as "secondary boycott," "feather-bedding," "closed shop," "illegal picketing," "mediation," "conciliation," and "arbitration" serve only to arouse his ire and get him farther off the alkaline side when he is unable to get a train, put in a phone call, purchase a newspaper, or if he is successful in any or all of these, have the lights turned off on him because there is no coal. And I need not mention the helpless plight of some of us in management who have to live with these things every day.

I am more fortunate than most of my contemporaries. I had a complete course in labor relations many years ago, at a tender and impressionable age, and all in the space of a few hours. It is this lesson that I now offer to my less fortunate brethren with the fervent hope that it will make their lives more bearable in these days of strife.

I was employed as a caddy at the swank Green Lake Country Club in the golden age of the roaring twenties. Such an engagement would probably have stamped me as an independent contractor rather than an employee under the Wagner Act, according to some, but the weight of authority would probably be to the effect that I was a casual or seasonal worker. I would report for work at the proper time and place, that is, the caddy house, at 7:00 a. m., rain or shine. There we had in operation the "hiring hall" where the first name on the list was the first to be hired. Of course we had rules of seniority under which class A caddies were given preference, but everyone agreed that this was just and equitable and not "discrimination as to hire."

The evils of the "shape" now plaguing our longshoremen were nonexistent with us. In other words, there was no such thing as everyone ganging around and hoping that he might be the fortunate one to be selected for work because of the color of his hair, shape of his nose, or other adequate considerations. It was just an orderly process of waiting one's turn, and if one's name was too far down the list so that there was no chance of a job that day, one went home, mowed the lawn, worked in the garden, washed dishes, or sought other forms of employment. Of course if one were fortunate enough to have achieved some degree of social security one might even go fishing.

Now in order to get your name on the work list at the caddy house you had to pay a caddy fee and obtain a badge or button—be accepted, that is. But membership was not denied any worthy applicant. We had no "closed union." No one was heard to question this procedure since it tended to keep out inferior caddies, raise the standard of work, develop a fraternal feeling among the caddies, and promote harmonious relations with the employers. Of course, such a "closed shop" today would be declared illegal under the Taft-Hartley Law, provided you were adjudged to be in interstate commerce, but then who isn't nowadays? Furthermore, judging by the way some of our golfers had of slicing and hooking into moving freight cars on the railroad which adjoined the course, I have no doubt that the Supreme Court would hold that we were in fact definitely engaged in an industry which affected interstate commerce. But in that golden era of "laissez-faire," "caveat emptor," and "rugged individualism" no such government intervention reared its ugly head to disturb the peaceful practice of our pursuit.

But one day a cloud came into our lives, as it must in even the best of labor relationships. Our wages for eighteen holes had been seventy-five cents, but the cost of chewing gum, bicycle tires, ice-cream sodas, not to mention movies and ball games, was going up. We thought we should be paid more. Every group in society produces a leader in times of stress and ours produced Willie Kovacks—"Big Willie," he with the strong physique, loud voice, bushy eyebrows, and heart of a lion. By the democratic process of acclamation he became our elected representative and hastened to present our demand of one dollar per round to the "Greens' Committee," the representatives of "top-management." This, my friends, was my introduction to "collective bargaining." We had learned, you see, that the caddies at near-by Balmoral Country Club were getting one dollar per round and felt we should get the "going rate" in the area, even though we had no "federation" or "trade council" with other courses. I did not realize it at the time but "industry-wide bargaining" was stoutly resisted by management then as it is now, and perhaps properly so.

Of course we had certain "fringe demands" too. If we were caught in the rain and had to stop after nine holes we felt we should be paid for the entire eighteen. This was getting paid for "work not performed," yes, but it was due to circumstances beyond our control and we knew of no law against it. The euphemistic term "feather-bedding" had not come into wide use (or abuse) as yet. When we had to carry two bags we wanted double pay, not pay and one half. After all, were we not producing double? We had some conception of "job analysis" and "job evaluation" even in those days.

When confronted with the demands made by our representative, "top-management" refused to deal with him, did not make a "counteroffer," and furthermore told him that he was fired from the course.

Returning to the caddy shed, Willie gravely announced the "breakdown of negotiations," and his own sad plight. We did not have the protective umbrella of the Wagner Act at the time and could not charge the Club with the "unfair labor practices" of "refusal to bargain" and "discrimination" before the National Labor Relations Board. Nor did we have the highly efficient present-day Federal Mediation and Conciliation Service which we could call in to try and effect a voluntary peaceful settlement. In short, we had reached an impasse and a "work stoppage" seemed imminent.

Apprehensive of trouble, the Club's professional held a hurried conference with management representatives and brought us a compromise offer of eighty-five cents per round and a flat denial of our "fringe demands," thus becoming the first "mediator" of my acquaintance. We refused and promptly took a strike vote which was unanimous, empowering Willie to call a strike at any time he thought was strategic, adding, of course, to our demands the "re-instatement with back pay," if any, of our leader.

This all occurred late one Saturday afternoon. It was too

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late for our employers to get an injunction. The Norris-LaGuardia Act protecting us against it, had not been passed yet and even though Messrs. Taft and Hartley were not too well known at the time, the employer could have proceeded to enjoin our action as an illegal conspiracy under the common law and even prosecute us under the Sherman Anti-Trust Act as had been done with the Danbury Hatters. There was hardly time for any of this, however, and since we were not subject to any "cooling-off period," the scene was set for Sunday morning. It is at this point that my lesson in labor relations really begins.

On the following beautiful balmy sunny Sunday morning as the august members of Green Lake turned from the highway into the drive leading to their clubhouse, they were greeted by a "picket line" which, of course, none of them had any qualms about crossing. There was no attempt, in fact, to prevent them from doing so; no blocking of entrances, no threats or coercion, no defamatory posters, no false statements. In other words, it was "peaceful picketing" in support of a "bona fide labor dispute" which the Supreme Court of the United States was to declare many years later was merely the exercise of our constitutional right of freedom of speech. Caddies who reported later were merely told that there was a strike in progress and in practically all cases they joined us. The few who crossed the line were hardly enough to affect the outcome of the strike and were branded as "scabs," a term of opprobrium with which they would forever be stamped in all self-respecting caddy circles.

Meanwhile consternation reigned on the first tee. Mr. Throckmorton was horrified at the indignity of carrying his own bag. Mr. Van Schuyler could not see far enough to watch his own ball. Mr. Apgar and Mr. Courtney would not think of playing without a caddy. Actually, there were just as few rugged individualists among them as there are in other groups of society.

Some of the members, intent on outsmarting us, went back to their cars and drove over to Balmoral to play. But Willie was smarter than they. Anticipating such a move, he had already dispatched a strike committee on their bicycles to Balmoral to induce the caddies there not to work for any of the "fugitive" players from Green Lake. Their bags were "hot cargo," and a real "secondary boycott" was in progress. Here again, let me hasten to say that this would be illegal today under the Taft-Hartley Law and we would be subject to an injunction. Failure to comply might result in Willie's being held in contempt and subject him to fine or imprisonment, or both.

One of the members, apparently having some shady connections, got busy on the phone and in a short while a truckload of sinister-looking characters was seen to approach the course. Yes, "strike-breakers" were being imported. The Byrnes Anti-Strike-Breaking Act had not been passed as yet and anyway, it is doubtful that any state lines had been crossed.

The would-be strike-breakers alighted from the truck, and at this point my memory is not too clear on the actual sequence of events. I remember only that things happened fast and before I knew it I was locked in an unfriendly embrace with a bearded youngster about twice my size and age. Yes, there was "violence on the picket line" that morning, but as to whether it was provoked by the strike-breakers or the strikers, I am afraid we shall never know.

A few of the intruders got up to the first tee and proceeded to caddy, but their work was so unsatisfactory that the players were seen to quit after three or four holes, several dollars, a few golf balls, and in some cases a few golf clubs poorer, but wiser in the merits of hiring only skilled union labor.

At this point, Mr. Remington, a dynamic, self-made man and one of the Club's most distinguished members, came down to take matters into his own hands. By-passing Willie and his, by now, quite belligerent circle of immediate supporters, he sought out a number of our more reticent members, offering them a dollar a round. He was attempting to start a "back to work movement" but we immediately sensed a "union busting" device. Those selected would, of course, have to agree to abandon the union and while we did not know that such an agreement was known by the infamous name of "yellow-dog contract," our sense of justice and decency rebelled at such a practice and we did not hesitate to express ourselves very plainly. The terms "interference," "restraint," and "coercion" had not come into vogue as yet, but we did not need Congress to tell us that such a "labor practice" was "unfair." Suffice it to say that Mr. Remington's efforts were fruitless, and to this day I have suspected that he was the one responsible for the strike-breakers.

Now, lest I have created the impression that the members of Green Lake were a lot of cruel ogres who feasted every morning on grilled working man, let me assure you that quite the contrary was the case. Most of them, as are most employers, were a fair-minded group of successful men who were willing to listen to reason when they knew all the facts. Within an hour it had gotten around the locker room, pro shop, clubhouse porch, and first tee that Green Lake was paying only seventy-five cents a round to its caddies while nearby Balmoral was paying a dollar. Was the finger of scorn to be pointed at such estimable gentlemen as they? Were they to be branded as "exploiters?" Absolutely not! The world should know that they were "progressive" men of as much distinction and prominence in their community as were the members of Balmoral, even though their dues were a little less. You see, my friends, that after all, "public opinion" does play an important part in labor relations and "ability to pay" is some criterion for the establishment of wage levels.

So it was not with great surprise that we soon saw Mr. Bass, the venerable old gentleman who was president of the club, approach Willie with outstretched hand. He had taken a backseat during the early negotiations, entrusting them to subordinates, but now that opinions were crystallized and the atmosphere cleared somewhat, he was prepared with an offer of settlement.

The one dollar of course we could have. We just hadn't made our position clear, and there would be no recriminations because of previous conduct. Mr. Bass was a born "negotiator," possessed of those rare social efficiencies that are unfortunately not readily transmissible from person to person. We listened to him and liked it. We even admired him for not agreeing with us on the fringe issues. Wasn't it true that when there was a "tight labor market," we had welcomed the fifty per cent extra for carrying double, rather than bring in more caddies and, after all, we were not walking around the course twice, were we? We allowed as how Mr. Bass was right and dropped that demand.

The issue of a round interrupted because of rain was not so easy. There was evidence to the effect that twelve holes and not nine was the number necessary for full pay at some courses. We agreed to abide by the Pro's decision and thus submitted the issue to "arbitration." The "arbitrator's award" was in favor of twelve holes and the strike was settled.

Most of this, my friends, took less time to happen than it does to tell. It was then only about ten o'clock. The "interruption to production," while serious, had not been calamitous. We cheerfully walked up to the tee, seized bags, and were off in a spirit of gay co-operation. The members (all except possibly, Mr. Remington, and I have since forgiven him) were proud of themselves too. I even saw one caddy turn over a

(*Continued on page 810*)

DESIGN *and* MANUFACTURE *for* PROFIT

By Means of High-Frequency Induction Heating

By H. B. OSBORN, JR.[1]

TOCCO DIVISION, THE OHIO CRANKSHAFT COMPANY, CLEVELAND, OHIO

INTRODUCTION

AMERICA is the youngest of the great nations of the world. Concurrently, she is also the greatest of the young nations. Our high standard of living is the envy of all other peoples on the earth. Our abundant and varied natural resources have made this possible, but, since this essentially has all come about in the last half century, we must give credit where credit is due, that is, to our assembly-line methods and mass production. In this same period wealth and wages increased markedly, but since wages depend only on the dollar's worth of income production per hour, wage increases cannot be made without a corresponding increase in productivity.

Today, faced with the highest wage scale in the history of our country and a far-below-par willingness to work on the part of labor, American manufacturers must adopt production methods and techniques which will reduce the direct labor charges that go into their products, and save on material. However, mechanization and modernization of industries and product manufacture do not eliminate jobs and create unemployment. All products sold profitably must have a market which can be created by selling the products at a price people can afford. Such a price necessitates the use of mass-production methods and good designs. The result is that demand gradually increases, and with increased production we employ more and more people.

Gray-bearded economists have decried the industrial revolution and everything that followed. Labor unions have generally fought the introduction of efficient processing methods, and slow downs are not the exception but the rule. Despite this and protective legislation of our "ivory-towered" planners, we employ more people today (60,000,000) than ever before in the history of our country. Furthermore, labor is less reluctant to accept new methods when they see that their jobs are made easier and yet more productive, and that better working conditions result.

The war had a tremendously stimulating effect on the wider acceptance of many new methods and procedures. Had it not been for many of these new developments in various fields, we never could have provided some of the necessities of war, nor could we have made any of them in the quantities and in the time required. Some depended upon the scientist as, for example, the atom bomb, but all needed the ingenuity of the American engineer.

Many are the processes and methods which have contributed to the progress of American industry, among which is the induction-heating of metals. This paper will be devoted to a discussion of the principles of high-frequency heating and the design of parts so processed.

GENERAL PRINCIPLES OF INDUCTION HEATING

Much has been written concerning the fundamental principles of high-frequency induction heating (1, 2, 3).[2] Suffice it to say that it is a method of heating metals wherein the part heated has been made the secondary of a simple transformer with alternating current flowing in its primary or the inductor designed to fit the work. Thus a similar flow of current is induced into the secondary and at such high concentration that the part heats rapidly. The concentration of energy is on the surface, producing the so-called skin effect. Assuming an efficiently designed inductor, the rate of heating depends upon the power used in proportion to the surface area, and the depth of metal in which the heat develops depends upon the frequency of the alternating current. The higher the frequency, the shallower will be the depth; however, heat flow by conduction accounts for the greater percentage of depth unless the heating time is limited to fractions of a second.

The following formulas will serve as a guide in evaluating the conditions mentioned, and show that power density, which controls heating time to reach a given temperature, is far more important than frequency

$$D_1 = \sqrt{\frac{4}{F}}$$

$$D_2 = \sqrt{0.0015\,T}$$

$$D_T = D_1 + D_2$$

where

D_1 = depth in inches of metal in which most of heat generated
F = frequency in cycles per second
D_2 = additional depth in inches resulting from thermal heat flow
T = heating time in seconds
D_T = total depth

(for heating to 1600 F minimum)

There is one limitation to these equations and that is the relationship of frequency to diameter of stock. The bar diameter must be sufficiently large to respond efficiently to the frequency employed; that is, the minimum frequency which can be used efficiently to heat a picked bar size may be estimated by the following equation

$$F = \frac{180}{R^2}$$

[1] Technical Director, Tocco Division.

Contributed by the Machine Design Division and presented at the Semi-Annual Meeting, Milwaukee, Wis., May 30-June 4, 1948, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

NOTE: A companion paper, "Designing for High-Frequency Induction-Heating," by J. T. Temin, was presented at the same session and will be published in ASME Transactions.—Editor.

[2] Numbers in parentheses refer to the Bibliography at the end of the paper.

where

F = frequency in cycles per second (minimum recommended is 1000 cycles)

R = radius in inches

A few quick calculations will show that when the stock size is quite large frequencies of less than 1000 cycles are indicated. Owing to electrical limitations and other details not considered appropriate to discuss here, a frequency of 1000 cycles is recommended when F calculates below this amount.

In addition to a minimum frequency limitation, there is also a maximum frequency dictated by the application. In other words, one does not attempt to use a high frequency which concentrates heat on the surface for a deep or through-heating application. The resulting temperature differentials would produce undesirable overheating of the surface. Furthermore, cost of equipment must be considered since, generally, the higher the frequency, the higher will be the cost in dollars per kilowatt of power output.

Although frequency values may seem to be important, only extreme differences have any practical significance. Thus, manufacturers have standardized not only upon frequency but power output as well. However, there is a broad overlapping of application limits of various frequencies and a single induction-heating unit can be adapted successfully to a wide variety of applications.

A most important feature which cannot be stressed too strongly is that as long as the stock being heated has sufficient size to respond to the frequency used, the type of material involved is of no consequence. For example, a $^1/_2$-in-diam bar can be heated just as efficiently by 10,000 cycles as by 500,000 cycles, whether the material be steel, brass, copper, or any other electrical conductor. This is an important point since it has often been stated erroneously that the heating of nonmagnetic materials such as brass or austenitic or stainless steel requires frequencies of several thousand cycles. Such a statement is not correct.

Being able to confine and control the heat developed by the high frequency to a part both radially and laterally, opened up tremendous possibilities in the production of parts requiring wear resistance and/or special physical properties, to say nothing of the use of these controls for heating for forging, annealing, normalizing, or brazing, and soldering of assemblies.

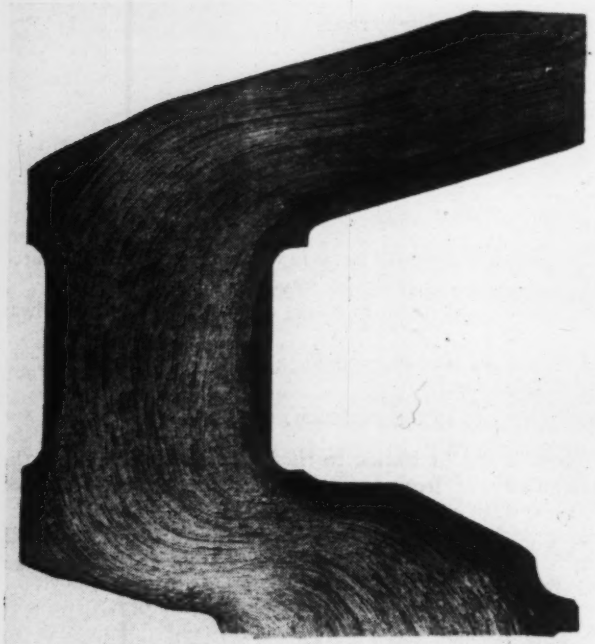

FIG. 1 MACROSECTION OF CRANKSHAFT BEARING SHOWING HARDENED AREA OF CONTROLLED RADIAL DEPTH AND LATERAL LOCATION

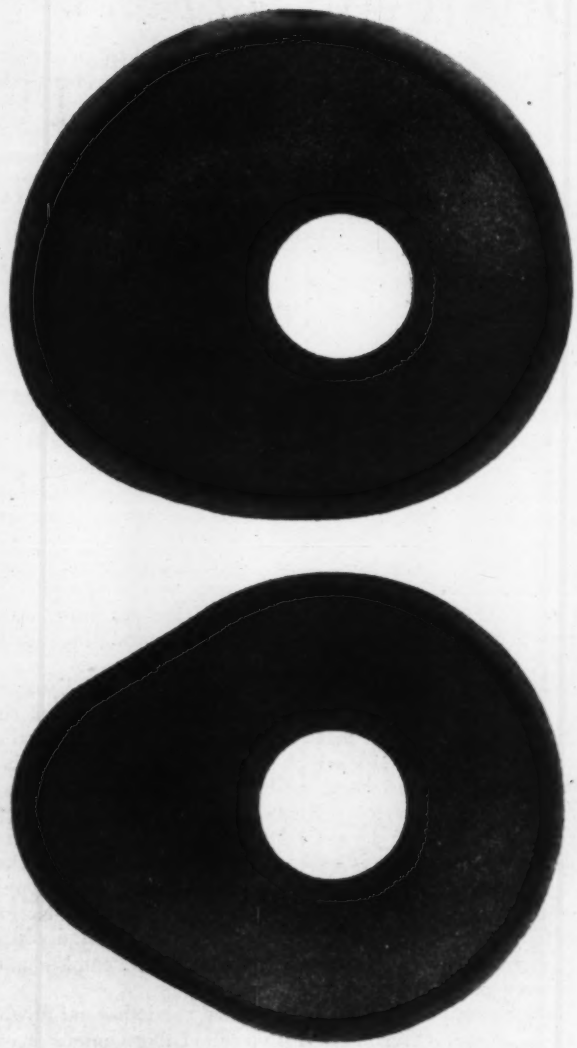

FIG. 2 MACROSECTIONS OF A CAM AND ECCENTRIC ON A CAMSHAFT (Contour hardened area due to skin effect.)

Control of depth by proper application of frequency makes possible the surface-hardening of bearing areas without distortion of the part or heating of adjacent areas; for example, hardening of a crankpin bearing or a cam on a camshaft (Figs. 1 and 2). The application of power continuously to a narrow band, followed by a quench, is used for surface-hardening of long areas to preclude the necessity of using impractical high power inputs to maintain power densities which permit surface-hardening (Fig. 3).

Many complicated assemblies are now made by brazing together simple subunits at a tremendous saving, as compared with machining from solid stock. The high frequency confines its heating to joint area and prevents the distortion which would accompany over-all heating.

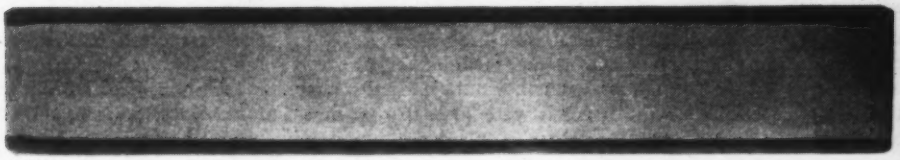

FIG. 3 MACROSECTION OF A CYLINDRICAL BAR
(Continuously hardened by progressive heat and quench.)

Other parts are completely finished before induction-heating. Instead of machining gears out of stock, heat-treated to a medium hardness range, we can machine a soft blank to size and then as a final operation, surface-harden by induction to high hardness range for greater wear resistance, Fig. 4(*b*).

DESIGN FOR USE OF INDUCTION HEATING

That feature of the induction-heating process, which makes it possible to confine heat accurately to the desired portions of metallic articles or assemblies, permits the adoption of this process on a most economical basis for the production of various commodities.

Confronted today with high labor cost and material costs, to say nothing of material shortages, manufacturers welcome design changes which permit a saving of material and/or labor. The automotive manufacture may well take a lesson from this statement. Prices on cars are high because of high material and labor cost, and low productivity per man-hour, but production deficiencies, which are blamed on material shortages, can be overcome by designing to use less material. As automobile bodies become larger and trim more extensive, the manufacturer tries to compensate by making the fenders and body thinner. A few basic examples of such conditions will serve to illustrate this point. In no instance will any reference be made to dimensions since all of the illustrations are typical and might apply to parts large or small.

Let us consider the necessity for producing a cylindrical object closed on one end, shown as detail A in Fig. 5. Conventional methods for producing this part could be as follows:

1. Machining from solid stock by removal of the material from the bore.
2. Casting to shape.
3. Forging to shape.

By the use of induction heating, we can produce the same item by starting with a tube of dimensions which would give the correct diameter and bore. A cylindrical disk may then be cut from a solid bar of suitable diameter and grooved around the central portion of its circumference to accommodate the brazing-alloy wire. Then, following prescribed details for fit and fluxing, depending upon the type of alloy used, which may include silver solder, brass, bronze, or even copper, the end assembly may be heated inductively to produce a tight joint of the plug to the base. Details of this are shown as B in Fig. 5, wherein we have produced the same detail requirements as shown in A.

An alternate design is detail C, Fig. 5, wherein the end of the tube has been recessed to accommodate a slightly larger plug. In this case the space required for the brazing alloy is provided

FIG. 4(*a*) EQUIPMENT FOR SURFACE-HARDENING PINIONS AND GEARS UP TO 36 IN. DIAM, 6 IN. WIDE, WITH 10,000 CYCLES

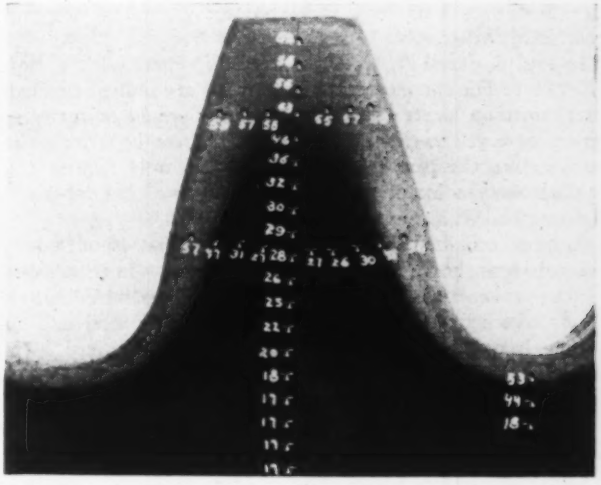

FIG. 4(*b*) MACROSECTION OF TEETH OF LARGE GEAR SURFACE-HARDENED ON EQUIPMENT SHOWN IN FIG. 4(*a*)
(Note hardness values Rockwell C.)

for by breaking the corner of the disk that is inserted into the recessed portion of the tube. This assembly is likewise inductively brazed to duplicate detail A.

In producing the part in accordance with either detail B or C, we have saved on material which would normally have been removed from the solid bar if it were made in that manner. Whether detail B or C is followed would depend upon the application as, for example, where high pressure might be applied against the end, detail C might be preferable to detail B.

Visualize a part similar to Fig. 5, but where we would be

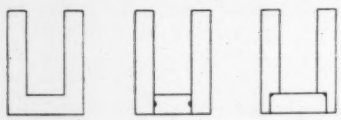

FIG. 5 DESIGNS OF TYPICAL CLOSED-END CYLINDRICAL PART

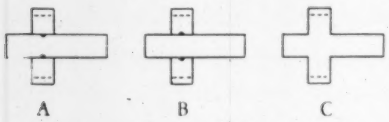

FIG. 6 GEAR AND SHAFT ASSEMBLY

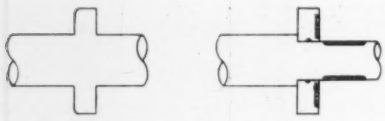

FIG. 7 COLLARED SHAFT

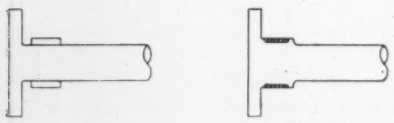

FIG. 8 SHAFT AND BEARING

required to have both ends closed. The same design details may be followed on both ends, producing an item not producible any other way.

In Fig. 6, detail A, we show a gear integral with a shaft assembly. For the most part, such items are limited to small sizes, since on larger assemblies the gears would normally be pinned or keyed to the shaft. However, it can be seen that to manufacture the part shown in detail A would require machining away a lot of stock; a costly operation laborwise and wasteful from the standpoint of material.

A more economical method of construction is offered by using designs shown in detail B or C in Fig. 6. In these cases, we have taken a shaft of the correct size and assembled onto it a gear which has been obtained by cutting disk sections from a long bar on which gear teeth have been machined. The assembly with brazing alloy is accomplished by the methods usually prescribed, with the groove either having been machined in the gear bore or in that area of the shaft over which the gear is to be attached.

Following the assembly, induction heating can be applied to affix the gear firmly to the shaft. In a few instances, applications are possible where heating is applied in such a manner that the gear teeth are brought to hardening temperature and the differential of heat allowed to flow to the bore, producing correct temperature for brazing. When quenched, the gear teeth harden, and brazing is accomplished simultaneously.

In Fig. 7, detail A shows a flange or thrust-face collar, as, for example, that used on a balancer shaft. In addition to a physical size requirement, it is necessary that a bearing area be prepared adjacent to the collar as well as a bearing surface on the thrust face of the collar. Conventional methods of processing would include machining the shaft from a large-diameter solid bar, or upsetting the flange on a smaller bar followed by carburizing and hardening. A change in design, depending upon the use of induction heating, is shown as detail B in Fig. 7, wherein the shaft is made from a bar diameter, as indicated, with recessed step, having assembled to it a collar with brazing-alloy groove as in the case of previous parts discussed. This assembly is then placed in a high-frequency inductor block, and in one operation the collar is brazed to the shaft, the thrust face of the collar is surface-hardened, and the bearing area adjacent to the collar surface-hardened The shaded area in detail B shows the hardened zones.

Fig. 8 is a typical assembly in which a change in design results in the elimination of a pressed-on bearing race. For example, in the case of an axle shaft, the bearing race shown in detail A has been pressed on the shaft to provide the necessary bearing area. By making a slight modification in the forging of the shaft and providing a diameter adjacent to the collar equivalent to that of the outside diameter of the pressed-on race, this area is then induction-hardened to produce the bearing surface shown as a shaded area in detail B, Fig. 8. Thus the axle shaft produced fits into the regular axle assembly and the hardened area of the shaft provides the necessary bearing raceway.

DESIGN DETAILS REQUIRED FOR INDUCTION-HEATING

Lest the idea be conveyed that induction-heating is a "cure-all" for all problems, we must not overlook the fact that there are certain basic requirements, both metallurgically and physically, to which the parts must conform before they can be considered as practical and economical induction-heating applications.

In order for a part to be hardened properly by induction-heating, it must have a chemical analysis wherein there is sufficient combined carbon to give the hardness requirements when it is heated and quenched properly. It is of interest to note, however, that with induction-heating slightly higher hardnesses can be obtained for a given carbon content of steel than with other methods.

As explained previously, the volume of metal that is heated by induction-heating attains its temperature both by induction of heat into the surface layers and conduction of heat to layers beneath. Hence there are many instances where the mass of metal beneath the hardened area must be taken into consideration when designing a part for induction heating.

For example, when requirements call for surface-hardening of cylindrical stock, the wall thickness has a pronounced effect on the ease with which the depth of hardness is controlled. A very thin-walled tube as, for example, one 0.100 in. thick, can be surface-hardened to a depth of 0.050/0.060 in., but either exceedingly high frequency or unusually high power densities at lower frequencies is required to prevent heat flow by conduction. On the other hand, a depth of 0.060 in. could be maintained quite readily on a tube of the same diameter but with a wall thickness of, say, 0.200 in.

A similar condition exists in the case of a gear with lightening holes, as, for example, that shown as detail A, Fig. 9. Note that the holes have been drilled directly beneath the root

of the tooth. Were we to induction-harden this gear, a reasonably good contour of hardness could be produced, but it would be difficult to prevent through-hardening from the root into the lightening holes. In fact, the hardening at this point doubtless would result in cracking. Detail B, Fig. 9, shows how the lightening holes, when properly located directly under the tooth rather than under the root, will satisfy the weight requirements and, at the same time, facilitate induction-hardening.

Let us next consider a wide gear as machined with a rather

FIG. 9 GEAR WITH LIGHTENING HOLES

FIG. 10 WIDE GEAR WITH OFF CENTER BODY

FIG. 11 FINE-PITCH GEAR

FIG. 12 FILLET DETAILS

FIG. 13 OIL-HOLE DETAILS

narrow web. Detail A, Fig. 10, shows such a gear. If we attempt to induction-harden this, the small amount of metal backing up the teeth on the one end of the gear will result in extreme distortion. The end result will be a gear which has belled considerably. Merely, by "beefing-up" the flange or web assembly and providing additional metal back of the teeth, as indicated in detail B, Fig. 10, we can overcome this difficulty. Fig. 11, detail A, shows a fine-pitch gear with a minimum of metal beneath the root. Attempt at induction-hardening either throughout the tooth section or contour hardening will, in most instances, produce through-hardening below the root. In order to overcome this difficulty the design of the gear should be changed to give at least as much depth under the tooth as the tooth height, preferably 50 per cent more (detail B).

The details, which have been discussed in both Figs. 10 and 11, can be applied likewise to ring gears, wherein the presence of lightening holes or holes used for other purposes, and lack of material under the root of the teeth produce through-hardening, cracking, and/or distortion.

In detail A, Fig. 12, is shown a typical fillet area on a part which, subsequently, may be induction-hardened on a bearing adjacent to the fillet. The use of a sharp fillet, as shown in detail A, is not to be recommended, since this will be a stress-raising area, and cracking, either at the time of hardening or in service, will be encountered. Detail B, Fig. 12, shows the recommended rounded fillet which should be used on all such parts. Obviously, this condition is quite critical on crankshafts.

Detail A, Fig. 13, shows a typical oil hole as drilled in a bearing surface as, for example, on a crankshaft, through the area which, subsequently, is to be induction-hardened. When the diameter of the hole is very small in comparison with the diameter of the bearing, careful filleting or rounding, where the oil hole comes through the surface, is not too critical. However, where the hole is quite large, as in the case where

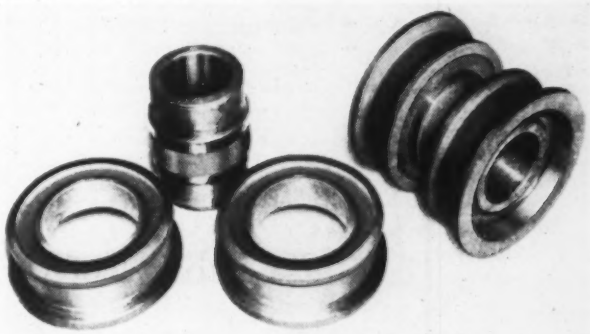

FIG. 14(*a*) TRACK-ROLLER ASSEMBLY

copious lubrication is needed, then it is necessary to fillet the areas carefully to prevent overheating of the sharp corners and the thin section adjacent to the acute angle of the oil hole (detail B).

CONCLUSION

The examples which have been cited present only in a very general way some of the potentialities available to the manufacturer who will investigate the use of induction-heating. Also, they indicate a few of the basic design details which must be adhered to in order to avoid difficulties. A specific example will be given in which, by designing a part for application of the induction-heating process, the manufacturer has been able from the savings accomplished to more than justify the cost of the necessary machine installation.

Fig. 14(*a*) shows a track-roller assembly used by tractor manufacturers. Prior to the adoption of induction heating, this roller was made in various ways. A rather expensive casting had proved to be satisfactory from the standpoint of service, but the cost was prohibitive. Another method of manufacture was that of using a forging but here, too, the cost of the forging plus subsequent machining was objectionable. Another alternative, and one which was used for experimental

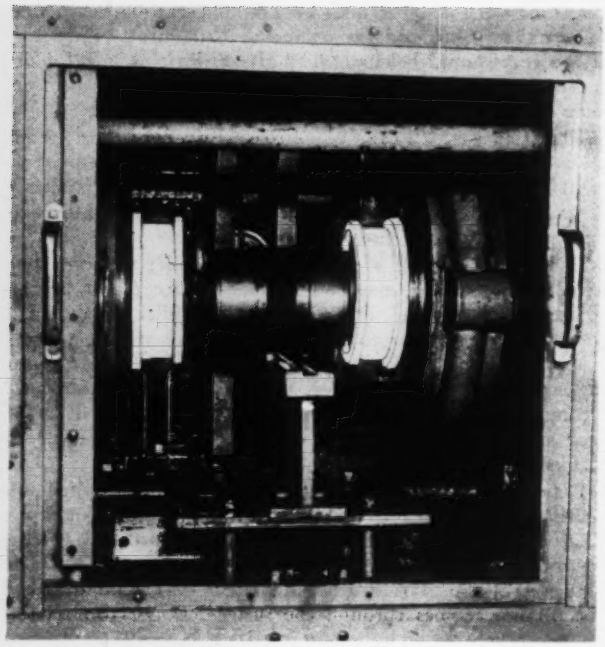

FIG. 14(*b*) EQUIPMENT FOR SURFACE-HARDENING ROLLERS AND SHRINK-FITTING TO HUB SIMULTANEOUSLY

purposes was that of machining the part out of a large-diameter bar. This necessitated a costly removal operation and waste of material. The final product was very expensive.

In an attempt to economize, experiments were conducted whereby the roller was made in three parts, the assembly of the flange to the hub being accomplished by welding. The final design, and one which is now standard practice, involves the use of induction heating for performing a dual task. The roller hub is inserted in an induction-hardening machine with the two rollers on either side with bores properly lined up with the hub ends. The two rollers are rotated through a specially designed high-frequency inductor and the surfaces of the rollers, which must be hardened for service, are brought up to hardening temperature.

Fig. 14(*b*) shows the hub in position and the two rollers after they have been heated to the required temperature. At this instant, the surface of the rollers is at a temperature which will permit hardening, but enough heat has drifted to the bore of the roller to expand it slightly. The hydraulic rams drive the roller over the hub and the quench is turned on automatically. This produces surface-hardening of the roller and adjacent flanges, and shrink-fits the roller to the hub simultaneously. The shrink-fitted joint is immeasurably stronger than a welded joint, due primarily to large area contact under pressure. Thus we have an example of a rather novel use of induction heating for the manufacture of a part which could not be produced, quality-wise or as cheaply, in any other manner.

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Labor Relations *in a* Nutshell

(*Continued from page 804*)

lost ball he had found, under an old rule, more honored in the breach than in the observance, and also saw the man give it back to the caddy.

Yes, my friends, there is no reason that our little differences, once settled, should cast any shadow on future good labor relations as some seem to think.

Willie Kovacks was subsequently appointed Caddy Master, a move, I am sure, having no such ulterior motive as to get him out of the "labor movement" by making him a part of management. His union activities had merely demonstrated his leadership abilities which management was now utilizing for the benefit of all concerned.

Now I hope that this little lesson in labor relations which I learned many years ago will serve to help you understand the problems and practices on the industrial scene today. But if you are still confused, do not be discouraged. Many before you have been in the same predicament.

Thumbing through a dusty tome some time ago I came across the following mellow statute which mirrors some of the feelings of its age and which both the proponents and opponents of the Taft-Hartley Law would do well to ponder. This applies especially to those who labor under the impression that we are dealing with a brand new problem. The parenthetical insertions are mine.

"Forasmuch as of late divers artificers, handicraftsmen and abourers have made confederacies (unions), and sworn mutual oaths (by-laws) that they should not meddle one with another's work (boycott), and finish that another hath begun (hot cargo) but also to appoint how much work they shall do in a day (feather-bedding) and what hours they shall work (union hours), contrary to the statutes of the realm and to the hurt and impoverishment of the King's subjects (public interest); therefore it is enacted that if anyone of them shall conspire (organize), covenant (make agreements), promise, or make any oaths (establish working rules) that they shall not do their work but at a certain price or rate (union scale) or shall not take upon them to finish that another hath begun (hot cargo), or shall do but a certain work in a day (feather-bedding), or shall not work but at certain hours and times (union hours), on conviction, every person so offending shall forfeit ten pounds."

That is taken from the Statutes of Edward VI, volumes 2 and 3, chapter 15, enacted in 1548, just four hundred years ago. I'll venture the opinion that neither because of this nor in spite of this, the human race has flourished considerably since that time. What we do through legislation in 1948 along this line will have about as much salutary effect as what we did in 1548. Human beings will still have to get together to work out their mutual problems for themselves, with an absolute minimum of help (or hindrance) from their governments. So, my friends, cheer up, there is still hope for all of us.

P. S. The author is now a member of "Green Lake."

A Pattern for
TOP EXECUTIVE ACTION

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TOP EXECUTIVE ACTION FOR BETTER HUMAN RELATIONS

THERE are many approaches to the promotion of better human relations in industry, but there is one which could combine the influences of all of them. Such a program would explore the extent to which outstandingly competent executives have, in addition to certain native and acquired qualifications, a uniform sequence of reasoning which, if formulated and transmitted throughout an organization, would provide that understanding of the rules of behavior which are so essential when men must work together.

That there is some sequence of executive thinking and action which makes the best use of management knowledge is evidenced by the similarity in the policies of successful corporations, and the general agreement of business leaders as to what is good practice. This uniform sequence might be termed "a pattern for top executive action," a dynamic combination of the best that is known in business adminstration. Seldom is it well balanced in any one company. Rarely does the man who directs the fortunes of his company take time out to tell how he does it, even if he could put it into words. He found out the hard way, and he leaves it to others to follow the same process.

Is it too much to expect that this elusive executive "know how" can be engineered into a compact mental package as a guide to the young men groping their way up to positions of responsibility?

The literature of management predominantly and logically deals with limited areas of interest. Such titles as "Incentives for Indirect Workers," "Budgetary Control," "Graphic Charting," "Executive Organization," "Time Study," are suggestive of the thousands of sections and subsections under which the subject of management is treated; thousands of puzzle pieces of truths which must be made to fit together into an integrated formula for top-management thinking, decision, and action.

The literature of management is meticulously indexed. It is possible to locate, with reasonable precision, any phase of a given subject. But if we accept the contention that what serves the leisurely pace of the student does not serve adequately the urgent needs of the man who has little time to look in the book, can something be done about it? Can what it says in the book ... the body of recorded management knowledge ... be reconciled with the facts of life as the businessman sees them and be expressed in his language? Can some sorting code be devised, by means of which the techniques and principles of the art and science of management, "the one best way" applying to a particular situation, be made to drop into a mental pocket ready for instantaneous use? Or will we go on reaching into Fibber McGee's closet for hard-earned skills each time we are up against a moment of critical decision?

Consider the position of the man in the middle management bracket striving to move ahead. Training, experience, common sense will carry him a long distance; but sooner or later he may face some situation for which he has had no more than casual preparation. The company pays for his trial-and-error experience, and he pays the price of delayed advancement.

Are there more effective ways of conveying to all key men a balanced appreciation of what consitutes good over-all administration so that all of the players will understand the signals and respond to them?

THE SEARCH FOR A PATTERN

It was such questions that, several years ago, led to the beginning of a systematic observation of the nature of the problems which confront executives and an attempt to match these situations with groups of recognized laws, techniques, and principles.

With such subjects as "Buildings and Equipment," "Personnel Relations," "Executive Organization," there was little difficulty, because recorded knowledge is grouped in much the same way as these problems occur in industry. However, a mass of other management subjects did not seem to be "mentally prepositioned for use."

It was not until the realization that a static classification of knowledge might not serve the dynamic needs of executive action that there was a clue to a rational approach.

In speculating on what must be a natural process of executive thinking, it seemed evident that a first consideration must always be an objective—a program—a plan, ranging from elementary sales, production, profit quotas to comprehensive short and long-term planning. Planning raises the questions of methods and standards of performance, and of buildings and equipment required. It raises questions of how responsibility and authority will be delegated, of the behavior and well being of the men and women who serve the company, and of the controls which management will have over operation.

Long-term planning raises questions of the open mind in research and development, of relations with customers, vendors, and the community, and of access to specialized services and information.

Out of this general approach, there gradually evolved, by a process of trial and error, a dynamic grouping, a "nine point pattern of executive action" intended to include in a logical sequence of attack all of the types of problems, decision, and action which confront top management, expressed in the language of the businessman.

At this point, the absence of exact, specialized management terminology such as used in engineering, chemistry, or medicine, and the necessity for using words which have a variety of associations, was a handicap.

NINE POINT GROUPING

Subject to this limitation the suggested pattern is as follows

OPERATION

100 Operating program
200 Methods and standards
300 Plant and equipment

Contributed by the Management Division and presented at the Semi-Annual Meeting, Milwaukee, Wis., May 30-June 5, 1948, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

ORGANIZATION

400 Executive organization
500 Personnel relations
600 Management controls

PROTECTION

700 Research and development
800 Public relations
900 Specialized services

If it should be found that every type of administrative problem, decision, and action, every major objective which impels executive action falls naturally into one or more of these nine headings, then it is the basis for understanding and agreement as to what constitutes sound administrative "know-how," a common understanding which is so essential when men must work together in harmony. It should prove to be a compact mental package of balanced considerations ready for instantaneous use upon all occasions.

As a first test assume the application to a broad over-all statement of management policies and objectives which might read as follows:

OPERATION

100 Preparation of an "operating program," selective transmission to those concerned, and maintenance of checks and balances to insure its execution
200 Development and maintenance of "methods and standards" consistent with accepted policies of economy, quality, and service
300 Selection, installation, and maintenance of "plant and equipment" in readiness for effective operation

ORGANIZATION

400 Design and effective functioning of an "executive organization" suited to the needs of the company
500 Promotion and maintenance of "personnel relations" consistent with high standards of social responsibility and sound business operation
600 Design and maintenance of "management controls" which will provide reliable and adequate information for guidance in making executive decisions

PROTECTION

700 Planning and maintenance of program of "research and development," designed to retain and advance company leadership
800 Planning and maintenance of a program of "public relations," designed to meet company responsibilities and secure and retain respect and good will in external relations
900 Appropriate use of "specialized services" wherever they may advantageously supplement normal operation

It is futile to formulate pious generalities and expect them to get very far with practical operating men unless these objectives are converted into "Operation X" in the terms of those who have to get things done.

Visualize three applications of "Operation X"... The "Nine Point Pattern for Executive Action" to any company with which the reader is familiar:

A1 Management manual
A2 Executive training
A3 Management valuation

MANAGEMENT MANUAL

The necessity for putting into writing certain policies, regulations, information, instructions relating to continuing operation is generally conceded. But management manuals maintained with rational completeness are the exception. There must be a new approach if the resistance to their extended use is to be overcome. In the fast moving pace of daily operation, it is impractical to pass all instructions through an editor who will dress them up in fine language. There must be some way of automatically coding written instruction of a continuing nature so that the manual builds up in the normal process of day-to-day requirements, subject to such periodic purging, simplification, and formalizing as reason dictates.

The Nine Point Pattern, expanded by decimal subdivisions, provides a natural index.

OPERATION

100 "Operating program," broken down into sales, production, financial, and other sections, sets forth policies and objectives for each division head
200 "Methods and standards" deals, essentially, with mechanics of performance and with standards of efficiency and quality. A major field is manufacturing processes to which time and motion study and work simplification apply
300 "Plant and equipment" covers selection, layout, maintenance, and specialized operating instructions for physical facilities

ORGANIZATION

400 "Executive organization" outlines delegation of responsibility and authority, and the pattern of executive relations and behavior
500 "Personnel relations" covers personnel policy, methods of job analysis, employee selection and training, and activities concerned with morale, rights, and protection of the individual
600 "Management controls" relates principally, although not exclusively, to systems, such as accounting, production, inventory, cost, process, sales, and other records used in administrative control

PROTECTION

700 "Research and development" covers investigative projects relating to products, methods, markets, costs, or any other subject selected for a special major study
800 "Public relations" recognizes dependence upon good will of customers, vendors, and public generally, and social responsibility to the community and to the country
900 "Specialized services" covers judicious use of accounting, legal, advertising, trade association, statistical, and other professional and specialized services

It will be noted that the three subjects grouped under "operation" are impersonal, while the three grouped under "organization" deal with people. The three grouped under "protection" emphasize the long-term safeguarding of the company's position. Each of the nine points applies not only to over-all administration but, with varying emphasis, to each division, department, or function.

INFORMATION, INSPIRATION, EDUCATION, TRAINING

"Operation X" in business requires "briefing;" i.e., the process of transmitting information, objectives, regulations, and instructions to all concerned, and the development of skills. The word "training" in general use is inadequate to cover this requirement, and it is suggested that it be expanded into the term, "information, inspiration, education, training."

At this point, the difference between a static classification of knowledge, as represented by the Dewey decimal system, and a dynamic classification of administrative action should be appreciated. One classifies the character of the information, the other classifies the activity to which the information may be applicable, just as in cost accounting the "account" indicates the character of the charge, the "department" the activity to which it applies.

The body of recorded management knowledge, if it is to be put to work, must be converted into decisions at the desk of the executive, at the point of the tool in the shop.

One of the finest examples of conversion of technical knowledge into practical use is that of "work simplification," which has been directed at the improvement of the mechanics of performance in shop, office, and even the laboratory.

(*Continued on page 814*)

EUROPE *Looks to* AMERICA *for* TECHNOLOGICAL ASSISTANCE

By JOHN A. WILLARD

BIGELOW, KENT, WILLARD & COMPANY, NEW YORK, N. Y. FELLOW ASME

WITH the ending of the recent war, Europeans began trying to find out what technical progress had been made in the United States during the war years. Engineering and management organizations in the free countries of Europe wrote to various sources in the United States asking for books on science, technology, and management, together with copies of technical papers in as great an amount as possible.

They assumed that under the pressure of a war economy we had made great advances in specialized techniques and improved methods. They knew, of course, that progress in their own countries had been almost unbelievable, and there was a great thirst for knowledge to correlate this experience with that of the laboratories and manufacturing plants of the United States.

These inquiries came from Greece, Czechoslovakia, Holland, Belgium, France, Switzerland, Norway, Sweden, Denmark, Finland, and England. Also, to a limited extent, some inquiries were received from Poland and Italy.

In the technical field, the so-called founder engineering societies received the greater portion of the requests for purely technical information. These are made up of The American Society of Mechanical Engineers, American Society of Civil Engineers, American Institute of Electrical Engineers, and the American Chemical Society.

In the management field the American Management Association, the Society for the Advancement of Management, the National Association of Cost Accountants, the National Management Council, and a large number of societies which specialize in more limited fields, such as the National Office Management Association, were asked for all available data on the development of management techniques.

All these organizations responded as liberally as their supplies of literature and budgets would permit, but still the needs have not been fully met.

Due to economic conditions, industry in many places in Europe has not been able to make the improvement in management techniques that has taken place in the United States. This leaves a definite need for all the technical literature we can send, to fill the demand that exists for knowledge of the impact of the war on American technology.

In some cases this desire to know the latest thinking on management techniques in the United States has had a special origin. It has come about as a result of young men from various European countries visiting and studying in America. Now that they have returned home, they are rapidly introducing programs with which they became familiar in America; adapted, of course, to foreign conditions.

EIGHTH INTERNATIONAL MANAGEMENT CONGRESS

The Eighth International Management Congress was held under the auspices of the International Committee for Scientific Management (CIOS) in Stockholm in July, 1947. The scheduling of this Congress soon after the ending of the war was deliberate. The necessity was recognized for bringing the world up to date on progress since the Seventh Congress was held at Washington in 1938. It was realized that plans being made for rehabilitation could best be carried out with a full and complete knowledge of the latest available techniques.

It was notable that Czechoslovakia, Great Britain, France, Holland, and Belgium, together with Denmark, Sweden, Finland, and Norway, all had tremendously worth-while contributions to make at this meeting.

Probably such Congresses are valuable most of all for the personal contacts which can be made, as well as the visits to local industrial plants and municipal and state facilities for schools, libraries, hospitals and the machinery of governmental administration. Nevertheless, it was evident at this Congress that intense desire existed to become acquainted with the latest American techniques.

After the Congress was over the author felt that it had accomplished a good deal in furthering the cause of management, particularly in spreading knowledge of management techniques to all strata of the business world.

EDUCATIONAL PROGRAMS

Since the close of the war, and in spite of the problem of obtaining sufficient foreign currency to support the program, there has been a tremendous resurgence of the movement behind international education. In particular, a considerable number of Swedish engineers, already well educated in their own country, have come to America for one or two-year courses in specialized sections of modern industry.

In Boston alone, there are at the present time 1500 young people from 70 different countries studying within the city and its suburbs. There has even been set up an International Student Center in Cambridge where these students can make friends with each other and with Americans. This center is especially active on week-ends when the pressure of study is less onerous. The impressions these students form of us are bound to affect our future international problems. We can only hope the imprint of Americans on this group is as favorable as that of the Swedish people in the course of the visit last year, referred to earlier. There the impression of national courtesy and friendliness to visitors from other lands was outstanding.

While exchange professorships are by no means new, this movement, too, has had a rebirth, as witness the recent exchange of Prof. David B. Porter of New York University with Prof. Robert Kristensson of the Royal Institute of Technology in Stockholm. Also, as a result of the Eighth International Management Congress, Dr. Harry Arthur Hopf was recently invited to spend two months lecturing in Scandinavia on management and organization problems.

In addition to the interest of Europeans in courses in technical management subjects here, there are engineers in many

Contributed by the Management Division and presented at the Semi-Annual Meeting, Milwaukee, Wis., May 30–June 2, 1948, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

countries on the Continent who are anxious to arrange for postgraduate training in America. During the trip last summer, in Holland, Belgium, France, and England, the desire was continuously expressed for plans to be worked out which would make this postgraduate work possible. Perhaps it could be said that less desire for these courses was voiced by the British; a fact that was undoubtedly due to their difficulty in getting a sufficient money allowance for traveling abroad. The restrictions on currency in England appear to be even more severe than in any of the other European countries.

SIGNIFICANCE OF THE MARSHALL PLAN

One other important factor in Europe's desire for American assistance is identified with the Marshall Plan.

Most of the materials which America is planning to distribute to Europe (if we exclude dried milk, eggs, dried fruits, cotton, and fuel), consist of fabricated products which the countries themselves cannot produce under their shattered manufacturing economy.

The items which we expect to send them in the greatest volume are trucks, farm machinery, mining machinery, freight cars, steel equipment, and timber equipment. Electrical equipment will go over also, but to a limited extent.

In the management field, it is understood that the effort will be to make management-engineering service and techniques more readily available and on a broader scale than in the past.

These products will be of direct use in themselves. They will be of almost equal use in making it possible for Europeans to study our designs and adapt them to their own conditions. It should not be forgotten that in most cases designs which have been produced in this country and are adaptable to a wide range of economic, geographic, and other conditions in America are not necessarily the best suited to conditions in Europe. As a matter of fact our machinery often has to be modified before it can develop maximum usefulness at minimum cost abroad.

For instance, in this country a person does not buy a Diesel unit unless it is going to operate almost full time because of the greater cost per horsepower. In Europe, on the other hand, many more Diesel units are used because of the relatively high cost of fuel. In Sweden, for example, practically all tractors are medium-compression semi-Diesel-type motors. Thus, it will be seen that the equipment we send abroad will not be of maximum long-time benefit unless it is selected with great care so as to conform to European economic and geographic conditions.

SIGNIFICANCE OF MILITARY OCCUPATION

Again, there is bound to be a marked effect in the occupied areas of Germany due to the presence of our armed forces and administrators. However, human nature will probably tend to make this effect fairly fugitive, since people resist absorption of ideologies from those who rule by force of arms. As a matter of fact it is feared we are not doing all we might to create the impression of better government. For instance, a trade paper recently stated that in the American Zone bureaucracy is consuming 1000 tons of paper a month, even as only 32 tons are allocated to newspapers, 70 to books, and 500 to periodicals.

CONCLUSION

In spite of this tremendous interest in American technology, we should be careful not to let ourselves get any idea that we are definitely superior to Europeans in thinking along technological lines. As a matter of fact, it is a sad commentary on American leadership that today the only gas turbines actually at work in plants in this country are in oil refineries employing the Houdry process. These turbines are made by the Allis-Chalmers Manufacturing Company under Brown-Boveri patents.

We should reflect, too, that it remained for the British and Germans to utilize the first practical jet engines. While we do have many distinguished scientists, born and trained in America, in many cases they owe their distinction to having developed and improved ideas originally conceived in Europe.

In management engineering, the Bureau des Temps Elémentaire of Paris has done especially outstanding work in the field of time and motion study. Again, British, Danish, and Swedish leaders in the field of farm management have done some noteworthy work not duplicated elsewhere. It is true that in the last fifteen years Professor Mundell of Purdue University has fathered an agricultural methods program in the United States which has been outstanding. At the same time, on account of their greater dependence upon the productivity of limited areas, European countries have delved deeply into the techniques of improving production for small acreage at minimum cost.

We might consider also the paper entitled "Studies of Working Methods in Swedish Forestry," presented to the Eighth International Management Congress by Mr. Luthman and Dr. Lundgren. This represents an application of fatigue studies which have not been attempted in the United States except at the Harvard Fatigue Laboratory, and there only to a limited extent.

Let us, therefore, forward this technological material to Europe in humbleness with the clear understanding in our own minds that new processes, whether of manufacturing or management, have always been influenced by local conditions. This is true here as well as abroad. European governmental, social, religious, political, and economic conditions are bound to affect the application of any general principles of management and methods of work. Thus, we can rest assured that these good people will not attempt to take over our methods blindly but will absorb American techniques and blend them with Europe's own to the vast improvement of both.

A Pattern for Top Executive Action

(*Continued from page 812*)

If the concept of "training within industry" could be broadened to "information, inspiration, education, and training" and focused on the nine management objectives, it could be a more effective contribution to that uniform appreciation of rational administrative practices which is so essential to good human relations.

MANAGEMENT VALUATION

The elusive character of management defies exact measurement. However, by assignment of point values to the nine objectives and their subdivisions, an approximate valuation of over-all balance and effectiveness can be determined with sufficient accuracy to be a practical guide.

It is suggested that a research project, comparing the operation of companies with similar ratings might disclose a firm basis of agreement on what constitutes good practice.

Better human relations involve a uniform appreciation of the character of problems which confront top management, and the considerations and sequence of reasoning leading up to decision and action.

This "pattern for executive action" is presented, not with any conviction that it is conclusive, but with the hope that it may suggest a new approach to the advancement of management understanding.

The DIFFICULTIES YOUNG MEN CONTEND WITH

A Suggested Program in Support of Post-College Engineering Training

By CLARENCE E. DAVIES

SECRETARY OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

THE concept is generally accepted that the engineer shall be competent in his techniques, alert to the social and economic implications of his work, and willing to take his place as a responsible citizen. Since he is a professional man, his educational process continues through life. His formal instruction at school can only start and give a sense of direction to the full scope of this education. Much must be left for his future career. The purpose of this paper, therefore, is to discuss the immediate post-college phases of the engineering graduate's further education, and to suggest a program of action to dignify and vitalize it.

NEED FOR POST-COLLEGE EDUCATION

That this is not a new problem to engineers is attested by the fact that the title of this address is taken from the oft-quoted official of the founding of The Institution of Civil Engineers, which says:

"It was toward the end of the year 1817 that a few gentlemen then beginning life, impressed by what they themselves felt were the difficulties young men had to contend with in gaining the knowledge requisite for the diversified practice for engineering, resolved to form themselves into a society."

This essentially educational impulse was evidenced throughout the then industrial world, and organizations of engineers formed in the pattern of the specialization of each particular country came into being. All had the basic purpose of aiding the self-education of engineers through interchange of experience. Today there are in the United States many national engineering bodies which provide to the young engineer some stimulus for self-development. Many carry on programs of lectures and discussions particularly designed to help the engineering graduate.

The first recognition of the nation-wide problem of post-college training was made in 1932, when the Engineers' Council for Professional Development was established with a program of four points, one of which was "to develop a plan for the further personal and professional development of young engineering graduates."

The importance of this portion of the program was supported by the final report of the investigation of engineering education, sponsored by the Society for the Promotion of Engineering Education, just after the first world war, in which appears the following quotation:

"It seems evident that the most urgent educational task now before the engineering profession is to create and direct an effective program of continuation education for the first five years after graduation from college, using the existing colleges as centers wherever possible, integrating into a larger program the many admirable training courses now maintained by employers, recognizing the more meritorious of the present correspondence and extension courses, adding to these as needed, and leading up to a certification by the national engineering societies."

The ECPD program of personal professional development was started with great vigor under the leadership of Robert I. Rees, a former president of ASEE, who had retired from active business and was devoting full time to ECPD. He assembled a strong committee supported by a carefully selected subcommittee of young graduates who helped him analyze their interests and needs. He had made a splendid start in an experimental integration of the educational efforts of industry, education, and the societies when his untimely death retarded further program. Tangible evidences of the work remain in the reading lists of technical and general books, in the self-appraisal form for young engineers, and in the list of extension facilities available for post-college training. The depression and the war brought the program to a full stop from which it is now being put in motion again.

So much for the past. What is the present situation and what does the future require? Why is post-college training more important now? What are the current difficulties the college graduate faces? What is the attitude of his employer?

Post-college training is more important now than in the past for a number of reasons. In the first place, the four-year or even five-year curriculum can only provide the necessary fundamentals in the necessary technical and socio-economic bases of engineering. Large industries are asking for graduates soundly trained in the fundamentals, to which each industry will add the necessary training in specialized applications. Government agencies, federal, state, and municipal, which are taking more graduates and may take even more in the future, have no plans for training other than what is necessary for the specific task for which the graduate is hired.[1] Small industry can usually only provide on-the-job training, yet in this field of small industry may lie the real opportunity of the graduate two, three, or four years from now when the supply of graduates catches up with and passes the demand from the large industries.[2]

Today the industrial structure has a more complex scientific basis. It is changing so rapidly that the educational processes cannot keep pace with it. We are living according to a more highly developed economic and social pattern that involves a better understanding by the engineer of the social and economic implications of his work. This will be particularly important in a future business recession for which the engineer may again be blamed because of the machines and economies he has pro-

Presented at the Fifty-Sixth Annual Meeting of the American Society for Engineering Education, Austin, Tex., June 15, 1948.

[1] "Opportunities for Engineers in the Federal Government," by J. H. Belknap, *Journal of Engineering Education*, vol. 38, April, 1948, pp. 517–521.

[2] "Special Engineering Requirements of the Small Industry," by G. L. Hartman, *Journal of Engineering Education*, vol. 38, May, 1948, pp. 622–626.

duced. All of these factors make it necessary that the engineering profession, engineering education, and industry assume an increased responsibility in the orientation and training of the engineering graduate.

What of the young graduate and the difficulties he faces? In the first place, he is in demand and is being paid more than ever before. While there are some exceptions, the evidence seems to be clear that he realizes he must work long and hard to earn his pay. The average graduate of the next two years may be older than in former years and the family responsibilities that have given him a seriousness of purpose at school should carry that seriousness of purpose to the job. Yet orientation into the post-collegiate environment is in general the same as it has been in years past. More may be expected of him, and the scientific complexities of his industry may be greater than those faced by his predecessors. The more intensive organization of industrial workers may involve him and may give rise to complicated problems of evaluating his own economic worth. He stands at a critical point and he is entitled to the support of the older men of his profession.

ATTITUDE OF INDUSTRY TOWARD GRADUATE TRAINING

The attitude of industry regarding selection, training, placement, advancement, guidance, and professional activities of engineering graduate employees was partially revealed in a preliminary survey[3] in 1946, of 104 employers in 19 fields of industry who employed 33,758 engineers. This survey, conducted by the Engineers Joint Council and published in the spring of 1947, revealed the following characteristics on the technical and professional development of engineering graduates.

"Only 50 per cent of the co-operators report that special provision is made for professional development of the young engineers in their employ, but practically all indicate that their engineering organization provides definite opportunities for professional advancement.

"Thirty-seven per cent have formal programs for young engineers; 65 per cent indicate that jobs are varied to provide a broad training; 41 per cent provide technical programs within the company; and 78 per cent encourage taking courses outside of company hours, of whom more than half contribute to the cost of tuition for such courses. (Some multiple choices are included in the foregoing percentages.)

"Practically all encourage membership in engineering societies. Nearly 30 per cent pay the dues of certain employees in certain societies. Traveling expenses usually are paid by employers for attendance at meetings when employees are authorized to serve on committees, prepare papers, present discussion, and the like."

The findings of this national survey were supported by a more recent survey of employers in the Milwaukee area made by the Engineers Society of Milwaukee.[4]

A further broader survey is now being organized and will be conducted by a committee of the Engineers Joint Council on which the ASEE is to be represented.

EFFECT OF STATE LICENSE LAWS

What is the probable effect of the engineering license on the post-college training of graduates? While all of the states now have license laws on their statue books, there is still a wide variation in the provisions of the laws which reduces their value as a national standard of attainment. In the high-standard states, which are relatively few, the attainment of the license provides a spur to post-college training. The provision in the model law for the engineer in training, which has been adopted by several states, dramatizes the need for a planned regimen of post-college study and acts as a stimulus to that end. Undoubtedly, in a national program of post-college training, the license has an important part.

What about unionization of engineers? Despite the fact that some principles governing union operation, such as featherbedding, reduction in productivity, and the submergence of the individual, are repugnant to the training and instincts of the engineering graduate, surveys of two large national societies showed that a substantial percentage of young men who had not attained supervisory responsibility felt that some form of organization was needed to protect their position. Some of these young men found themselves in large groups of engineers where their individuality has been lost. Others were involved, many against their will, in strikes called by organizations with which they were grouped for bargaining purposes. Enlightened managers have placed on themselves the responsibility for the correction of this situation involving the protection of the creative power of the engineer.

While provisions in the Taft-Hartley Act make it possible for professional people to be dealt with as professionals, the general problem is a long way from solution. The state laws which govern a great many employers of engineers lack provisions similar to those embodied in the Taft-Hartley Act. The attitude of the employer of the young graduate has an important bearing on his recognition as a potential professional and as a part of management. In securing this recognition and in encouraging the proper training of the young graduate to attain that recognition, the organized engineering profession has a grave responsibility.

At this point, recognition should be given to the splendid offerings by the engineering schools of evening, extension, correspondence, and graduate courses, particularly in centers of engineering and industrial activity, and to many engineering societies which offer orientation and review courses of great value in the post-college training of the young graduate.

FUTURE PROGRAM

In considering a future program, the first element is the attitude of the young graduate himself. It is quite obvious that after several years of instruction in an engineering school the graduate may welcome a release from formal routine. It is important, therefore, that there be incentive or recognition to provide that necessary self-satisfaction the graduate must have if he is to continue his education.

The future program is a responsibility of the organized profession at national and local levels, of the employers, and of educational institutions. To make such a program more specific, some suggestions will be given.

Engineers' Council for Professional Development. ECPD is at the focus of real responsibility in this program. Its charter contains the necessary provision to enable ECPD to develop the program and follow its administration. Its make-up, with representation of the national societies, of education, of the state licensing boards, and of leaders in industrial training, gives it a standing necessary for the successful prosecution of a program. Specifically, ECPD might undertake the following activities:

1 Develop and promulgate a clear national policy on post-college training.

[3] "Employer Practice Regarding Engineering Graduates, Report of Preliminary Survey," MECHANICAL ENGINEERING, vol. 69, April, 1947, pp. 306–308.

"Employer Practice Regarding Engineering Graduates, Supplemental Report," MECHANICAL ENGINEERING, vol. 70, January, 1948, pp. 13–16.

[4] "Engineering Training: Relations of the University and Industry in Developing Engineers," by W. P. Schmitter; "Industry Develops Engineers," by Theodore B. Jochem, and "Milwaukee Plan of Aptitude Testing," by E. C. Koerper, presented at the ASME Semi-Annual Meeting, Milwaukee, Wis., May 30–June 5, 1948, and published in MECHANICAL ENGINEERING, vol. 70, September, 1948, pp. 743–746, 747–749 and 767, 750–751, respectively.

2 Be prepared to aid and support local organizations of engineers who are carrying on a post-college training program.

3 Collect and disseminate experiences of local engineering groups in post-college training for the useful help of all.

4 Support the early completion of the survey being started by Engineers Joint Council of employers practices regarding young engineering graduates.

5 Bring to a conclusion the efforts now under way to co-ordinate the various grades of membership of the principal national engineering societies, giving consideration to the qualifications for the license and the manner of granting the professional degree by educational institutions—all to the end that a scheme of measuring attainment in post-college training better recognized by the engineer's employer will be brought about.

6 Prepare and distribute literature helpful and stimulating to the young engineering graduate.

7 Develop a procedure for easing the transition from academic to industrial life.

National Engineering Societies. The traditional purposes and activities of the engineering societies are essentially educational and they can render valuable assistance directly as well as through their members who occupy positions of leadership in industry and engineering, and can be particularly constructive in interesting the employers of engineers in a well-balanced post-college training program.

Specifically, the societies should accomplish the following

1 Co-operate wholeheartedly in the ECPD program.

2 Encourage their local sections to participate in local engineering activities related to post-college training. If no activity is existent, encourage the sections to determine the needs of the local graduates and set up the necessary activities to meet the needs.

Local Engineering Societies or Groups. The post-college training program is obviously a part of the graduate's community life and therefore the local society must take the lead at the local level.

Specifically, these local engineering societies or groups should undertake the following:

1 Study the needs of young graduates for post-college study and co-operate with local industries and engineering schools in developing a balanced program of training that will cover the technical and the socioeconomic fields of an engineer's education.

2 In particular, seek out means of aiding employees of Government and small industry whose employers are not equipped to provide adequate post-college training.

3 Co-operate in the ECPD program.

Some local engineering societies have already started work. The Engineers' Society of Milwaukee has started a particularly constructive program under a Professional Development Committee whose objectives are the better selection and evaluation of engineering personnel with a view to their more effective utilization and recognition. The Milwaukee plan is well worth careful study by all those interested in this problem.

A constructive approach for local engineering groups to follow has been outlined in detail by J. R. Van Pelt.[5]

The Engineering Schools. The post-college program is essentially an education process, and leadership from the engineering schools will be particularly helpful.

In particular, the schools might advance the program as follows:

1 Review the scope of the present offerings of extension, correspondence, and graduate courses in the light of the present needs of the young graduates and make the necessary modifications.

2 Co-operate in the programs of ECPD and local engineering groups.

3 Review the present steps taken in the institution to orient the graduate to his industrial career and, if necessary, revise them to emphasize the post-college training the graduate will need.

The Employer. The employer of the engineering graduate is in a position of direct responsibility in such a program. By direct training methods, by providing opportunity for diversity of experience, and by encouraging the graduate to participate in educational and civic activities, the employer can make a valuable contribution to the development of the graduate into an engineer sound in his technology and qualified to handle his social responsibilities with skill and statesmanship. The employer can assist greatly by making sure that the young engineering graduate is recognized as an individual and a potential professional man. As is obvious from the report of employer practice,[3] there is opportunity for improvement in the training and orientation of the engineering graduate. It is not necessary to await the final report now being started to initiate a program with employers. There is much to be done.

The foregoing program has many ramifications, and it will require a high degree of leadership and imagination and a competent organization.

The increasing dependency of the nation upon sound engineering technology, and the danger that the engineer may not be broad enough to deal with the economic and social implications of his work constitutes a challenge and a job for the societies, the schools, and particularly for the employer.

[5] "Tomorrow's Engineers," by J. R. Van Pelt, *Journal of Engineering Education*, vol. 38, November, 1947, pp. 167–174.

Standard Locomotive Practice

ACCORDING to an announcement by the Locomotive Manufacturers' Association of Great Britain, all locomotives—steam, Diesel, electric, and from mainline to industrial duties—built in Great Britain for export, will henceforth be constructed to standard tolerances to provide interchangeability and standardization to such a degree as to simplify considerably running-shed maintenance replacements, shop overhauls, and the ordering and assembly of spare parts, particularly where a user has locomotives from two or three makers.

The only exceptions to this rule will be those where customers specifically ask for other tolerances to be embodied. Actually, the limits and fits now put forward do not cut across the majority of existing individual specifications, all of which were carefully considered by the LMA subcommittee charged with the work.

Built up partly on the "hole basis" and partly on the "shaft basis" to meet the special problems of locomotive-parts manufacture and renewal, the standard practice now adopted is listed in the Association's book under 14 headings, covering all of the machinery, much of the chassis, and some of the boiler details. Adequate illustrations and tables are included to make the practice self-explanatory.

It is stated that there seems to be no weighty reason why practices now adopted after lengthy investigation by plants capable of supplying more than 2000 locomotives a year throughout the world could not be introduced as a world-wide standard, and eliminating the multifarious systems of small application which help to make locomotive manufacture and locomotive maintenance more costly and difficult than they need be.

STATISTICAL METHODS *in* ENGINEERING *and* INDUSTRY: POSTWAR DEVELOPMENT[1]

By HAROLD A. FREEMAN

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DURING the war years, statistical methods were successfully applied to problems ranging from the inspection of material to the design of military equipment and military strategy. Partly in consequence of the practical experience so gained by statisticians, the postwar years have brought a great extension of the application of these methods to engineering and industrial problems. In this article we shall review briefly some of the factors which made recent advances in this field possible and refer to sources in which these advances are described in detail.

Although our interest here is in applications it must be stated that a foremost factor in the rapid growth of engineering and industrial statistics has been the general strengthening and expansion of mathematical statistics. Well-staffed centers of mathematical statistics have been established at Princeton, Columbia, North Carolina, Iowa State, and California. At these centers and elsewhere, individual and group research, often following the pattern of wartime research, has been extensive both in mathematical statistics and in its many applications. Moreover, men and women trained in mathematical statistics at these centers or earlier, at wartime centers such as the National Defense Research Committee's centers at Columbia and Princeton, have spread throughout the country and are largely responsible for many of the recent developments in the application of newer statistical techniques to engineering and industrial problems.

A second factor has been the formation of the American Society for Quality Control. This society came into existence several years ago as a federation of local groups composed principally of industrial personnel who were active in some practical aspect of quality control and who had been introduced to statistical techniques in one way or another, often by wartime courses, notably those conducted by the War Production Board. It has grown to a national society of thirty chapters and over two thousand members; it publishes a bimonthly journal, *Industrial Quality Control*, and it plays a leading role in developing and maintaining interest in statistical quality control and statistical methods generally among engineering and industrial personnel in such branches of industrial life as research, development, production, and management.

Another important factor has been the investment in statistical theory and its applications by the National Bureau of Standards. Within the Bureau a division titled the National Applied Mathematics Laboratories has been created, and under it, four sections, namely, the Institute of Numerical Analysis, the Computation Laboratory, the Statistical Engineering Laboratory, and the Machine Development Laboratory, have been established. These sections have already made significant contributions to statistical problems encountered in sampling inspection and specifications, and they have produced a number of valuable tables. It seems likely that this division will become a leading center of applied statistics in this country.

International visits by two of the leading personalities in the field of industrial statistics have been stimulating. Dr Walter A. Shewhart of the Bell Telephone Laboratories, the American pioneer in this field, recently returned from an extended visit to India where he lectured and consulted on statistical quality control. Mr. L. H. C. Tippett of the British Cotton Industry Research Association, a leading British authority, recently gave a series of lectures on statistical methods for quality control, technical investigation, and experimentation before a very large academic and industrial audience at the Massachusetts Institute of Technology; his lectures were followed by several shorter series at other American colleges and statistical centers.

As is well known by now, the kinds of engineering and industrial problems that have been successfully attacked by statistical methods are many. A broad classification would include sampling inspection of all types of material and equipment, the problem of tolerances in engineering assemblies, the problems of engineering design, generally, systematic quality control, and the planning and execution of experiments in the laboratory and factory, to say nothing of the many diverse problems arising in physics, chemistry, and all branches of engineering which are amenable to statistical treatment but which cannot be briefly classified except as problems in scientific research. Some of these applications are being reported in three American journals, the *Annals of Mathematical Statistics*, *Journal of the American Statistical Association* and *Industrial Quality Control*, and in British and Indian journals, notably the *Journal of the Royal Statistical Society* and *Sankhyā* (the *Indian Journal of Statistics*). The regular publications of the National Applied Mathematics Laboratories are becoming important sources of information in the field of applied statistics.

A number of postwar books have appeared in the field of mathematical and applied statistics. Most significant among them is Cramér's "Mathematical Methods of Statistics," a rigorous and unified discussion, at an advanced mathematical level, of probability theory and mathematical statistics. This theory underlies almost all sound developments in engineering and industrial statistics and a knowledge of it is useful if not perhaps indispensable for effective work in these fields. A good, general, introductory textbook requiring only a modest knowledge of calculus is Hoel's "Introduction to Mathematical Statistics." More specialized recent books include A. Wald's "Sequential Analysis," an exposition of the author's new methods, which may roughly be described as methods for analyzing data *while* they are being collected rather than after the collection is completed; "Techniques of Statistical Analysis," by the Statistical Research Group of Columbia University, a compendium of methods developed by this unit at Columbia for use on wartime problems, but which have many immediate peacetime possiblities; "Sampling Inspection," by the same authors, which provides the most extensive coverage of this subject to date; Grant's "Statistical Quality Control," recently reviewed at some length in this journal; and Brownlee's "Industrial Experimentation," a good, current book on the application of statistical methods to problems encountered in experimentation.

[1] One of a series of reviews of current economic literature affecting Engineering prepared by members of the Department of Economics and Social Science, Massachusetts Institute of Technology, at the request of the Management Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Opinions expressed are those of the reviewer.

UNESCO *and* ENGINEERING

OF particular interest to engineers anxious to promote international co-operation is the United Nations Educational, Scientific and Cultural Organization, known as UNESCO. The purpose of this organization, one of the specialized agencies of the UN, is to contribute to peace and security by promoting collaboration among the nations through education, science, and culture. UNESCO carries out its functions through a program aimed to encourage the reconstruction of war-devastated areas; the increase of international exchanges—of persons, skills, and materials; and in general the diffusion of knowledge to build a firm basis for international understanding and lasting peace.

Each of the 39 member states of UNESCO participates on a national level in executing this program. For this purpose there has been established in this country the U. S. National Commission for UNESCO which advises this Government in matters relating to UNESCO, serves as an agency of liaison with organizations, institutions, and individuals interested in matters relating to the activities of UNESCO, and promotes an understanding of the general objectives of UNESCO on the part of the people of the United States. The Commission, appointed by the Secretary of State, is headed by Milton S. Eisenhower, president of the Kansas State College of Agriculture and Applied Science, and is composed of 100 persons, 60 of whom represent national voluntary organizations, and the remainder are selected from federal, state, and local governments, or chosen at large. The members represent not only associations of an educational, scientific, and cultural nature, but also women's organizations, youth-serving groups, labor unions, farm groups, and religious bodies. In their personal and organizational capacities, these persons can contribute to the implementation of UNESCO's program a wealth of interest, experience, and resources.

Science is represented in the U. S. National Commission for UNESCO by twelve of its members, eight of whom are representatives of organizations: American Philosophical Society, Merle Tuve; American Association for the Advancemen of Science, Harlow Shapley; American Chemical Society, Harold C. Urey; American Society for Engineering Education, Huber O. Croft (member ASME); Association of American Medical Colleges, Walter O. Bloedorn; Engineers Joint Council, Robert M. Gates (past-president ASME); National Academy of Science, Ross G. Harrison; and National Research Council, Detlev Bronk. There is also one member-at-large, Arthur H. Compton, chancellor, Washington University; one member chosen from the offices of the Federal Government, Alexander Wetmore, secretary of the Smithsonian Institution; and two members from state governments, Reuben Gustavson, chancellor, University of Nebraska, and Blake R. Van Leer, member ASME, president, Georgia School of Technology.

The program of UNESCO, as approved by the Second Session of the UNESCO General Conference in Mexico City, is divided into six chapters, one of which is Natural Sciences. Major projects include: The maintenance of field science co-operation office in Latin America, the Middle East, Far East, and Southeast Asia; establishment of an international institute of the Hylean Amazon; provision of grants-in-aid to certain international scientific organizations; making of UNESCO a world center of scientific liaison; and, in general, co-operation with all international scientific efforts.

The National Commission has delegated corporate responsibility for implementation of this chapter to the National Research Council, which with its 90 affiliated societies is considered pre-eminently qualified in scientific matters. Among the Council's affiliates are the American Society for Engineering Education, the Engineering Foundation, and the many engineering groups representing the various branches of the profession: chemical, civil, consulting, electrical, mechanical, mining and metallurgical, radio, etc. It is to these organizations that the Council will turn for advice and action.

At its first session in 1948, the Executive Board of UNESCO approved the allocation of $232,254 for grants-in-aid to the International Council of Scientific Unions and its 10 federated unions; these unions had the advantage of several decades of experience when UNESCO was formed and are in an excellent position to undertake important parts of the UNESCO program. Engineers have only recently organized on the international level—by establishing the World Engineering Conference, at a meeting in Paris in 1946.[1] This new organization, which has national committees in 12 countries, has the endorsement of the U. S. Joint Engineering Council.

UNESCO, which is interested in the establishment of international organizations in engineering sciences, arranged a contract in October, 1947, with the World Engineering Conference whereby the latter would carry out a survey of existing engineering institutions, societies, and associations in the various countries. The Director General of UNESCO reported in June, 1948, that this project is nearing completion. This survey, with reports being prepared by experts, will prepare the way for furthering international co-operation in the engineering sciences and serve as a basis for the development, in UNESCO's program, of projects of interest to the engineering world.

There is no need, however, for private groups in the United States to delay their international activities until UNESCO has had the opportunity to adopt specific projects. Many organizations, particularly educational institutions, have initiated and sponsored programs of exchanges of students and professors, have awarded scholarships for foreign students to study in the United States, have established courses in teaching about the UN and UNESCO, and have sent materials abroad to refurnish schools, libraries, and laboratories.

A striking example of a voluntary effort to foster the exchange of knowledge and to build international understanding has been the Foreign Student Summer Project at the Massachusetts Institute of Technology. In a co-operative effort by American students, M.I.T. officials, and local business groups, funds were raised and arrangements made to bring 70 graduate students of science and engineering from 17 European nations to Cambridge for a three-month seminar.

In explaining their plan, the M.I.T. students stated that "the immediate reconstruction of Europe can best be directed by scientists and engineers with a knowledge of the technical advances made in the past few years. Thus the project, designed to bring advanced students to one of the best sources of technical information in the world, allows them a short while to investigate recent developments in their specialty, observe the latest in equipment, and note available sources of information for the future. They will return immediately to Europe, where they are needed now. Moreover, contact with Americans as they live is worth a world of radio propaganda and textbook information. These students will be the future leaders in their countries and the project will be a good investment in future international co-operation."

Prepared in consultation with the Department of State, U. S. A., at the suggestion of Robert M. Gates, past-president ASME, representative of Engineers Joint Council on the U. S. National Commission for UNESCO. For further comment see page 791.—EDITOR.

[1] See MECHANICAL ENGINEERING, vol. 68, 1946, pp. 977 and 978.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

COMPILED AND EDITED BY J. J. JAKLITSCH, JR.

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

Atomic-Energy Program

THE U. S. Atomic Energy Commission, through its Fourth Semiannual Report to Congress, disclosed information concerning Operation "Sandstone," under which code name a program of tests of atomic weapons and observations of nuclear phenomena was carried out during the spring of this year. Aside from the sparse coverage of this project because of defense and security regulations, other important phases of the atomic-energy program are amply covered in the report.

The publishable information about the atomic-weapons tests revealed that three nuclear explosions were involved and were carried out under conditions as close to laboratory control as possible, and with very extensive instrumentation.

Technical and experimental work was primarily designed to obtain answers to specific questions arising in connection with the instantaneous release of nuclear energy for its explosive effects. Subsidiary to the scientific aspects, there was a second group of observations carried out by several agencies of the Armed Forces, designed to fill in the gaps in the knowledge sought at Bikini with respect to the effects of atomic explosions on materiél and equipment

It should be pointed out that investigative emphasis at Eniwetok was placed on the scientific aspects because new designs of weapons were being tested, whereas at Bikini the principal emphasis was placed on measurement of the effects of the nuclear explosion, rather than on the generation of the nuclear explosion itself.

Much of the technical data recorded at Eniwetok is of course still being analyzed and evaluated. The results are generally clear, however, and the tests proved not only the effectiveness of the new designs of weapons but confirmed a great deal of the theoretical and experimental work performed at the Los Alamos Scientific Laboratory since the war. The experimental data gained at Eniwetok is important to future research and development, both for weapons and for nonmilitary areas of knowledge and application.

The Atomic Energy Commission reports that Operation Sandstone confirms the fact that the position of the United States in the field of atomic weapons has been substantially improved.

ISOTOPES

Isotopes for scientific, medical, agricultural, and industrial use constitute the first great contribution of the development of atomic energy to peacetime welfare. Industrial power from nuclear energy may be a decade or longer in the future and most other applications are still largely speculative. But isotopes produced in the Nation's atomic-energy establishment at Oak Ridge, Tenn., are already at work in more than 300 laboratories and hospitals in this country and abroad, adding to man's store of knowledge about himself and the world around him.

Isotopes assist science in two ways: as sources of radiation for many potentially important uses including the treatment of disease and as "tracers" of processes formerly difficult or impossible to observe. As tracers, they are proving themselves the most useful new research tool since the invention of the microscope in the seventeenth century; in fact, they represent that rarest of all scientific advances, a new mode of perception.

Using tracer isotopes, the scientist and engineer can observe atoms as they take part in basic organic and inorganic reactions, much as though the atoms were visibly tagged or labeled. For the first time it becomes possible to follow in intimate detail nature's fundamental processes, such as photosynthesis, metabolism, and the chemistry of hydrocarbons.

EDUCATION AND TRAINING

Educational programs in nuclear physics are under way at all three of the AEC national laboratories—at Argonne in Chicago, Brookhaven on Long Island, and at Oak Ridge, Tenn.—with 58 associated educational institutions participating in this work. Recently the Commission announced the award of research fellowships in 24 institutions, where students already well grounded in biological and physical sciences will receive advanced training in fields related to atomic energy. The University of California; the University of Chicago; Iowa State College; Washington University, St. Louis; and the University of Wisconsin are already offering courses in radioactivity techniques as part of their regular curricula.

How to Obtain Further Information on "Briefing the Record" Items

MATERIAL for this section is abstracted from: (1) technical magazines; (2) news stories and releases of manufacturers, Government agencies, and other institutions; and (3) ASME technical papers not preprinted for meetings. Abstracts of ASME preprints will be found in the "ASME Technical Digest" section.

For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources, i.e.: (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original manuscripts of these papers are available. Photostat copies may be purchased from the Library at usual rates, 40 cents per page.

PARTICLE ACCELERATORS

The number of particle accelerators—cyclotrons, synchrotrons, betatrons, linear accelerators, etc.—in operation in 50 U. S. laboratories and at least 10 abroad will be more than doubled by construction that is already scheduled. At least two dozen of the new atom smashers will be capable of bombarding the nucleus with particles accelerated to more than 100 million electron volts—an energy produced by only a single machine today, according to the report.

The Commission's particle accelerator program has been marked by two important events in 1948. The meson, a primary nuclear particle, was artificially produced and observed in the laboratory for the first time in the giant 184-in. synchrocyclotron operated with AEC funds in the Radiation Laboratory of the University of California at Berkeley; and plans were completed by the contractors and staff of the Commission for the construction of two new multibillion-electron-volt proton-synchrotrons, many times more powerful than the present Berkeley machine.

On February 21, workers in the Berkeley Radiation Laboratory achieved one of the major objectives of modern research in nuclear physics; they recorded on photographic emulsion plates placed within the 184-in. cyclotron the presence of mesons, hitherto observed only in cosmic rays. The meson (also called the mesotron) is an evanescent high-energy particle intimately associated with those fundamental nuclear processes that are still largely mysterious to scientists. When available under controlled laboratory conditions, the meson is expected to be an important tool for studying the nature of the forces that hold the nucleus together.

Before the meson can be understood and exploited as a laboratory tool, however, more powerful atom smashers must be built. The 184-in. Berkeley machine—the world's greatest at this time—possesses barely enough power to produce low-energy mesons. During the past year, physicists in the Commission's laboratories have been studying the feasibility of constructing electronuclear machines powerful enough to accelerate particles to energies of several billion electron volts. By the end of 1947, the Berkeley Radiation Laboratory and the AEC's Brookhaven National Laboratory on Long Island had completed the necessary theoretical work and submitted proposals to build such machines. After staff study, and upon the recommendation of its General Advisory Committee, the Commission approved, in April, the following specific plans for machine construction:

A 30-ft-radius proton-synchrotron to be constructed at Brookhaven; to yield protons with energies between two and three billion electron volts (Bev); to take about three years to build; and to cost approximately $3,000,000.

A 55-ft-radius proton-synchrotron to be constructed at Berkeley; to yield protons with energies between 6 and 7 Bev; to take four or five years to build; and to cost approximately $9,000,000.

The Brookhaven machine, accelerating protons in a track almost four times the radius of that of the present Berkeley cyclotron, will develop energies about seven times as great—sufficient to produce mesons plentifully. The Berkeley proton-synchrotron is expected to accelerate particles with approximately 18 times as much energy as the 184-in. cyclotron. Not even its designers venture to predict the nuclear phenomena that it will reveal, the report states.

The synchrotron principle for the multibillion-volt acceleration of protons was conceived independently during the war by physicists in the United States, Great Britain, and Russia. Thus far the only known plans for such machines abroad have been made at the University of Birmingham, England, where construction is already under way.

Today there are more than 50 particle accelerators operating in the United States in the high-energy (million electron volt) range. An almost equal number are now scheduled for construction. A few of these, notably the synchrocyclotrons under construction at Columbia University, the University of Chicago, and the Carnegie Institute of Technology, are to be giant atom smashers with power in the range of that of the 184-in. cyclotron, designed to extend the frontiers of fundamental knowledge.

There are now seven particle accelerators of various types working in the Commission's program. Three more are under construction; and 10 others are planned.

Accelerators now in operation are located at the Radiation Laboratory in Berkeley and the Los Alamos Scientific Laboratory. In addition to the 184-in. cyclotron, Berkeley has a 60-in. cyclotron (a pioneer machine, in which plutonium was first produced), which has operated steadily for more than a year bombarding materials for the Commission's research projects, chiefly in the field of biology and medicine, at Berkeley and Oak Ridge. Also at Berkeley is a linear accelerator constructed on an experimental basis to determine the possibility of producing billion-volt protons by straight-line acceleration. Now that experience has shown the proton-synchrotron design to be more feasible for this purpose, the completed section of the linear accelerator has been put to work in physical investigations in the 20 to 40 million-electron-volt range. At Los Alamos are four accelerators working in the specialized physical research associated with the program of that laboratory; a 40-in. cyclotron, a 20-Mev betatron, a 2-Mev Van de Graaff generator, and a 200-Kev Cockcroft-Walton accelerator.

Now under construction in Commission laboratories are:

A synchrotron (virtually complete) at Berkeley which will for the first time accelerate electrons to energies of 300 million electron volts. The machine may prove capable of splitting nuclear particles: neutrons and protons.

A Van de Graaff electrostatic generator (4 Mev) at Argonne National Laboraory, chiefly for the study of the nuclear characteristics of materials used in the reactor program.

A Van de Graaff generator (3.5 Mev) at Brookhaven National Laboratory, for general nuclear research.

Scheduled for construction, in addition to the two previously described multibillion-volt machines at Brookhaven and Berkeley, are:

Two 60-in. cyclotrons (30 Mev) for Argonne and Brookhaven National Laboratories, to be used in both physical and medical research.

Five betatrons for various laboratories of the Commission and institutions in its program, to produce high-energy radiations for use mainly in medical research.

A Van de Graaff generator (12 Mev) for Los Alamos Laboratory, for special research in nuclear physics. This type of electrostatic generator makes possible a variation and precise control of particle energy not feasible with the multimillion-volt cyclotrons and synchrotrons, and the Los Alamos machine will provide data much needed for solution of the nuclear physics, chemistry, and engineering problems of that laboratory. It will be more than twice as powerful as any similar machine now in existence.

ATOMIC POWER

Two reactors are now authorized for construction which should produce atomic power and which should be completed within the next two or three years. Neither unit can conceivably rate as an economic producer of power. But, as a result of experience gained in these, and their successors, there will start

a program of reaching higher temperatures and at the same time satisfying some of the criteria necessary for practicality and economy. Fairly practical reactors, that might be useful for special purposes, may then be available on an experimental basis within a decade.

The Commission states, however, that it is not seen how it would be possible under the most favorable circumstances to have any considerable portion of the present power supply of the world replaced by nuclear fuel before the expiration of 20 years.

High-Compression Engines

HOW high-compression engines promise large gains in fuel economy if high-octane gasoline can be made available at a reasonable cost to the consumer, was discussed recently at a San Francisco sectional meeting of the Society of Automotive Engineers, by John M. Campbell, Darl F. Caris, and Dr. Lloyd L. Withrow of the General Motors Research Laboratories Division.

It was the first over-all summary of "the engine-fuel relationship as it now faces the (automotive) industry" since the June, 1947, SAE meeting at French Lick, Ind., where GM Research consultant Charles F. Kettering, Fellow ASME, announced development of a 12.5-to-1-ratio engine for test purposes (see MECHANICAL ENGINEERING, July, 1947, pp. 594 and 595).

According to the report, comparative studies of standard-production engines and a Research Laboratories six-cylinder test engine with a 12.5-to-1 compression ratio already have shown fuel economy ranging up to 40 per cent, plus an efficiency increase over the standard engine.

The report said that with the high-compression engine still greater gains in road load economy are to be had at car speeds lower than 40 mph. This is the explanation of the extremely favorable results that have been obtained in city traffic conditions with the car fitted with the high-compression engine.

It is stated that gains as high as 50 per cent have been observed in tests made to compare the high-compression engine with the 6.5-to-1 engine under city traffic conditions.

Road tests show that the high-compression engine is up to accepted standards of smoothness, flexibility, and performance in general. Starting is satisfactory with the standard six-volt starting motor.

Ignition is obtained with a six-volt battery system using a conventional coil with some modifications. This experimental engine of 12.5 compression ratio is said to have demonstrated two very important principles:

1 That high-compression engines can be made to conform with accepted standards of smoothness and general performance characteristics demanded of present-day automobile engines.

2 That large gains in fuel economy can yet be made over current levels provided suitable fuel can be made available at a reasonable cost to the consumer.

Since the original experimental six-cylinder engine was built, the report revealed that GM has turned out several engines suitable for commercial production at compression ratios intermediate between current production levels and that of the experimental 12.5 compression engine.

From experience gained with these engines it has been possible to establish approximate relationship between octane rating and fuel economy, the report said.

Two of these 8-to-1 ratios were tested because they could be operated with some of the better premium grades of gasoline sold commercially since the war. The researchers said that with these fuels, gains in economy as high as 25 per cent were realized. Gains in fuel economy of from 10 to 25 per cent are possible at octane levels not much above those established by some present premium gasolines, and still greater gains can be made at higher octane levels. These gains have been demonstrated repeatedly in several engines all using the high-compression principle plus engine design changes incident to the use of high-compression ratio and supported by thousands of miles of operation in different makes of cars and under a wide range of conditions.

In discussing the immediate future possibilities of the fuel-engine relationship, the authors stated that the gains that can be made in fuel economy must more than offset the increase in the cost of high-octane fuel required in order to create a balance that is favorable toward increasing compression ratio. However, gains running as high as 40 per cent in fuel economy without loss in "performance" are sufficient to offset a considerable increase in the cost of fuel.

They said that recently it has been pointed out that the petroleum industry now has manufacturing capacity to produce about 20 per cent of its total volume of gasoline in the 96 to 98 research-octane range. This would be sufficient to supply gasoline for several years' production of cars requiring this type of fuel. But to produce still greater quantities of the 96 to 98-octane fuel as the demand expanded would require drastic capital equipment readjustments within the petroleum industry.

For that reason, the paper said, a study of a dual-fuel system has been proposed in which the carburetor would be supplied with both high and low-octane-number gasoline; the high-octane gasoline to be used only during the time that the throttle is open wide enough to require high-octane fuel.

By this means the effectiveness of a given limited quantity of high-octane gasoline could be greatly extended.

Another proposal involves the injection of a mixture of methyl alcohol, water, and tetraethyl lead.

The practicability of these proposals and the public acceptance of fuel systems of this kind in place of established fuel systems remain to be determined.

In any case, whether or not these proposals eventually receive wide public acceptance, the commercial production of engines requiring fuel having an octane number above that of commercial fuels now available at filling stations requires the distribution of a suitable high-octane fuel on a nation-wide basis.

The problem of distributing fuels on a nation-wide basis that will permit the introduction of automobiles capable of taking full advantage of such fuels is at once a challenge and an opportunity for the continued progressive development of fuels and engines such as has occurred over the past 20 years.

Stephenson Centenary

ENGINEERING exhibitions and commemoration services marking the George Stephenson Centenary, were held August 12 to 28, 1948, in the Borough of Chesterfield, England. An interesting brochure received from the Stephenson Centenary Committee gives a short biography of Stephenson and lists and describes the events that took place during the commemoration period.

According to the brochure George Stephenson, often referred to as the "Father of Railways," was born a poor pit lad on June 9, 1781, and died a man of world renown on August 12, 1848, the adviser, associate, and friend of kings and noblemen, the most prominent, able, and influential engineer in the world the face of which he had changed by his work. Assisted later in life by his son, Robert, he not only built successful locomo-

tives; he tunneled the earth, bridged rivers, and filled up swamps to make railways with traveling engines, of which he was the first to see the economic possibilities. Before any public railway had been built, while still a colliery enginewright who could hardly read, he made remarkably accurate prophecies. He said he would make it possible for a man to breakfast in Edinburgh and have supper in London, then a journey of many days' duration by stage coaches. To effect his purpose he had to design plant and organize labor on a scale never before attempted, and he took the most prominent part in organizing the biggest combinations of capital and labor the world had yet known. His railway work took him to Russia, Austria, Spain, and Belgium, where in each case he was personally consulted by the sovereign. He was knighted in Belgium in 1837 and in Austria he was a most honored guest. He refused an English knighthood, preferring, as he said, to remain without flourishes before or after his name.

Through the co-operation of the Science Museum, The Institution of Mechanical Engineers (founded in 1837 by George Stephenson), and many other institutions, together with the loan of items from private individuals, it was possible for the Chesterfield Library and Museum Committee to present a representative collection of documents, illustrations, plans, and other material, including many of the personal possessions of George Stephenson.

The illustrated brochure and centenary program is available from the Town Clerk's office, Town Hall, Chesterfield, England, at two shillings per copy.

Phenolic Molding Material Tests

THE results of mechanical tests of macerated phenolic molding material were reported in a paper presented by Prof. William N. Findley, Mem. ASME, College of Engineering, University of Illinois, Urbana, Ill., at the 1947 ASME Annual Meeting, Atlantic City, N. J.

The following tests were performed at a constant temperature of 77 F and constant relative humidity of 50 per cent: Short-time "static" tests in tension, compression, and torsion were conducted to determine the ultimate strength, yield strength, and modulus of elasticity under the three conditions of loading; torsion tests of hollow and solid specimens were conducted at several speeds of testing to determine the effect of speed on the results of static tests; compression tests of specimens subjected to three different "conditioning" procedures were conducted to study the effect of conditioning on the results of tests; Charpy and Izod impact tests were conducted; creep tests and tests for time to fracture under a constant load were conducted at different stresses; bending fatigue tests were conducted to determine

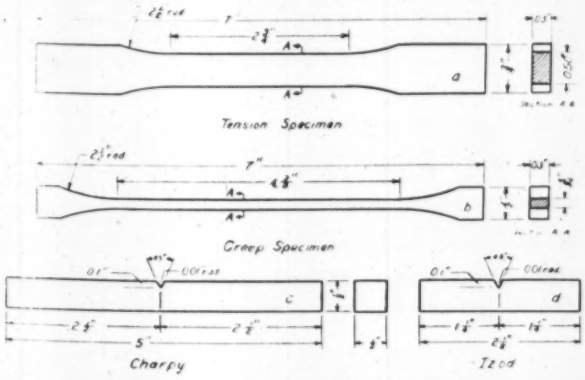

FIG. 1 PHENOLIC-MOLDING-MATERIAL IMPACT SPECIMENS

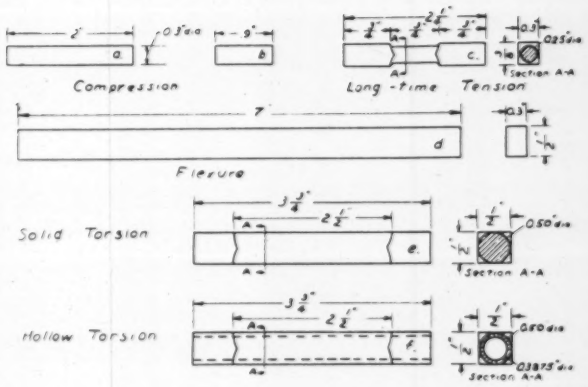

FIG. 2 PHENOLIC-MOLDING-MATERIAL STATIC SPECIMENS

the effect of different ranges of stress on the fatigue strength; rotating-beam fatigue tests were conducted to study the effect of speed of testing and the effect of notches on the fatigue strength; and fatigue tests in torsion were conducted to determine the fatigue strength under this type of loading.

The macerated phenolic molding material for these tests was supplied by the Plastics Division of the Monsanto Chemical Company.

The molding composition contained 50 per cent of a one-stage phenol-formaldehyde resin and 50 per cent of cotton denim and twill rag, cut in $^3/_4$-in. pieces. The "cabinet closing time" (a measure of plasticity) was 70 to 80 sec. The material was preformed at 20 C and 7000 psi. Two separate preforms were used per molded slab in order to obtain the required thicknesses.

Sheets, 5 × 7 in., were molded of this material in two thicknesses, namely 0.3 in. and 0.5 in. The 0.5-in. slabs were molded 35 min at 170 C and 7000 psi. These molding conditions were established by preliminary experimentation at the Monsanto Laboratory.

The specimens used in these tests were machined from 5 × 7-in. sheets of the macerated molding material and were preconditioned in an air-conditioned laboratory for at least two weeks after machining before the tests were started.

The following conclusions were drawn from the tests:

Static short-time tension and compression tests performed at the same rate of strain indicate about equal values of yield strength in tension and compression, 4010 psi and 4120 psi, respectively (at 0.05 per cent offset).

The ultimate strength in compression is, however, about four times the ultimate strength in tension, 18,960 psi and 4550 psi, respectively.

The moduli of elasticity are nearly equal in tension and compression, 981,000 psi and 886,000 psi.

Torsion tests at a rate of strain corresponding to that used for the tension and compression tests showed a yield strength (at 0.05 per cent offset) about 60 per cent of the corresponding value in tension and compression, 2550 psi.

The modulus of elasticity in shear was about one fourth of that in tension and compression, 234,000 psi in one group of specimens—290,000 psi in another group.

Torsion tests at different rates of strain showed that the shearing yield strength increased with increasing rate of strain up to a rate of strain of about 0.01 in. per in. per min.

It was found that a time of about 40 days was required for the specific weight to approach equilibrium in an atmosphere of constant temperature and humidity. The change in specific weight was attributed to change in moisture content.

The compressive strength of the material changed during the

time that the moisture content was not in equilibrium with the humidity of the atmosphere. The strength increased during the time that the moisture content of the material was greater than that required for equilibrium with the atmosphere, and decreased during the time that the moisture content was less than that required for equilibrium with the atmosphere.

The modulus of rupture in flexure was found to be 8000 psi.

The average energy absorbed in breaking a $1/2 \times 1/2$-in. Izod impact specimen was 20 in-lb. Whereas, the average energy absorbed by a $1/2 \times 1/2$-in. Charpy specimen was 15.6 in-lb. There was no appreciable difference in impact strength of specimens with notch cut parallel to the surface of the sheet and specimens with notch cut perpendicular to this surface.

Creep tests at several different stresses showed that the amount of creep and rate of creep are increased by an increase in stress. It was also observed that the largest proportion of the creep recorded occurred during the early part of the test.

It was observed that the creep versus time curve approached a horizontal line after a time of about 3000 hr for all values of stress.

Tension tests conducted at a constant load for long periods of time showed a critical stress of 3200 psi above which fracture occurred within less than 100 hr and below which fracture did not occur for a long period of time.

The fatigue strength for completely reversed bending stress was found to be 3130 psi at 100,000,000 cycles.

Tests at other ranges of stress showed that the fatigue strength decreased with increasing mean stress from 3130 psi at zero mean stress to 1610 psi at a mean stress of 7000 psi.

Relaxation of stress occurred during fatigue tests in which the range of stress was not zero. The relaxation rate was found to be affected not only by the value of the mean stress but also by the presence of an alternating stress.

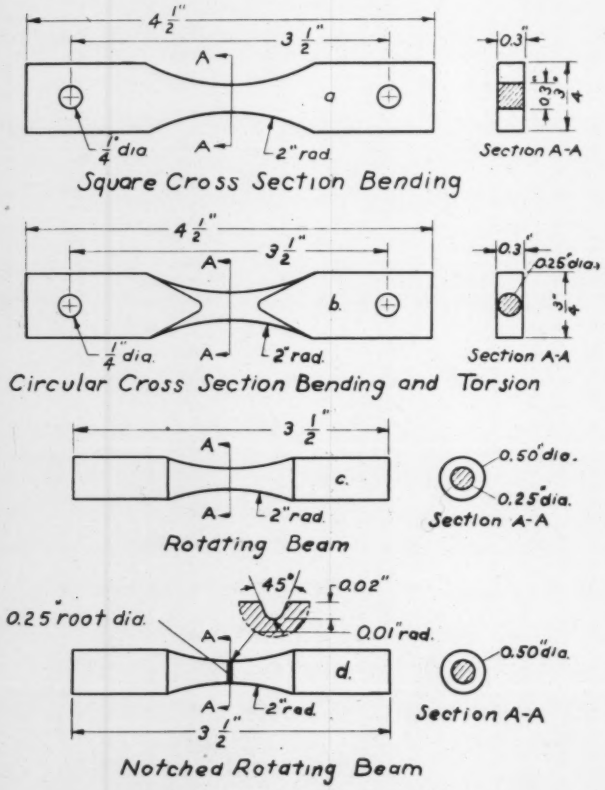

FIG. 3 PHENOLIC-MOLDING-MATERIAL FATIGUE SPECIMENS

The fatigue strength in torsion was 1800 psi shearing stress at 100,000,000 cycles.

The fatigue strength of a circular cross-section specimen in bending was found to be 3820 psi, which was about twice the fatigue strength of identical specimens in torsion. This indicates that shearing stress may be the governing stress which initiates the fatigue crack.

Rotating-beam fatigue tests at different speeds of testing showed that the fatigue strength decreased as the speed of testing increased.

Tests of notched rotating-beam specimens indicated very little notch sensitivity. There was some indication that the presence of a notch increased the fatigue strength.

Differences of 20 to 30 per cent in fatigue strength were found for different shapes of specimens and different types of testing machines.

Supersonic-Aircraft Pilots

SUPER flying machines are being built to hurtle through the stratosphere at speeds above sound. What about the pilots who are to fly them? Will they be able to operate efficiently, even survive, under the unnatural conditions imposed by supersonic flight ten miles above the earth?

Three of the nation's foremost test pilots, Gene May, Robert Brush, and Russ Thaw of Douglas Aircraft Company, Inc.'s Flight Test Division, attempted to answer this question recently before leading engineers at the Institute of Aeronautical Sciences summer meeting, Los Angeles, Calif.

Robert Brush, chief pilot, told the engineers that remarkable advances in high-speed aircraft design have placed mankind at the threshold of speeds unlimited. But unless more thought is given to designing superspeed machines for the men who are to fly them, the human problems may retard progress, he said.

Gene May, who has flown the official world's fastest airplane, the Navy Douglas D-558 Skystreak since its first flight, said that high-speed, high-altitude cockpits would have to be redesigned for comfort and visibility.

He declared that with speeds and altitudes increasing rapidly, the pilot can't be crammed into a narrow enclosure with hardly room for his head. With all the gadgets and controls he has to operate and the cumbersome equipment he must wear, the speed pilot often has the confused sensation of being a five-point traffic cop with all lights turning green at once.

For supersonic flight, he recommended "push-button" automatic control of the airplane to aid the pilot. He said that the pilot should be housed comfortably in a cockpit that is a self-contained "cell" or "room."

The test pilots said that flying at stratospheric altitudes with the present encumbrances the pilot must wear to sustain life, is extremely difficult and uncomfortable.

At altitudes beyond 20,000 ft the air thins out and pilots must breathe oxygen from a central system of the airplane. To provide a pressure equal to normal sea-level existence air is forced into the sealed cockpit.

A great amount of special equipment must be connected to and worn by the pilot who flies under such conditions. Mr. Thaw believes that if much of this equipment is eliminated the pilot will be more efficient. He will have a better chance of survival in case he has to make an emergency escape.

He said that a pilot cannot do his best when encumbered with a heavy crash helmet, uncomfortable oxygen mask that limits vision, an emergency oxygen bottle, and regulator. Then there is the shoulder harness and belt, "G" suit, parachute, and rubber vest for jumping over water. There are the connections for the receiver headset, oxygen mask, and G suit. All these are

usually dangling about the cockpit. This is not to mention goggles, gloves, and writing pad.

The pilots recommended that oxygen supply be attached to the pilot's person rather than the airplane's central system. They said that cockpits should be pressurized at 12,000 ft when flying at 40,000 ft as one step toward simplification.

Mr. Thaw advocated revolutionary methods of emergency escape from fast fighter aircraft.

The pilot should be propelled in an ejection seat from the cockpit through an opening in the bottom of the airplane. This would help to eliminate danger of being hit by the airplane's structure. An escape hatch should be provided on top in case the airplane is upside down when the emergency occurs.

Noise in the cockpit of jet aircraft under high-altitude pressurization should be reduced so that the pilot can hear the first signs of mechanical distress and not lose valuable seconds in getting out.

Speed-reduction devices such as the fuselage flaps or brakes used on the Douglas Skystreak and AD-Skyraider were advised to slow airplanes to a speed where the pilot could make his emergency jump with safety.

For future supersonic flight approaching 1500 mph, Mr. Thaw advised that the cockpit cell should be a "one-push-button" ejection arrangement. The pilot would push a button and the cell would be automatically expelled toward the earth with the pilot inside. Parachute or brakes would open automatically to decelerate it. An automatically opening parachute would permit it to land with easy impact. The one-push-button cell would be watertight for landing on water.

In the ideal supersonic-cell cockpit the pilot would require only a microphone, G suit, and writing pad.

British Atomic-Research Center

THE Atomic Energy Research Establishment at Harwell, England, which was founded in November, 1945, when the British government allocated an airfield as a nucleus for accommodation for the purpose, is described in *Engineering*, July 30, 1948. According to the article, the first duty imposed on the Harwell establishment was to carry out fundamental research and development on atomic energy. For this purpose a graphite low-energy experimental pile, the Gleep, was built, and was completed in August, 1947.

The Gleep is being used at present for the measurement of the properties of atomic nuclei, for testing the nuclear properties of the materials used in the construction of piles, and for the production of radioactive isotopes for biological, medical, and industrial research. An average of 80 specimens of radioactive isotopes have been prepared monthly since September, 1947.

The construction of the second, or British Experimental Pile (Bepo), was begun in one of the original hangars in June, 1946. This pile has a rated output of 6000 kw, although it is only slightly larger than the Gleep. It has been designed primarily as an experimental tool and will be used for testing the effect of high-intensity radioactivity on the structural and physical properties of the materials that will be used in future piles. It will also be the main source of radioactive isotopes for medical and research purposes in England and will enable these materials to be supplied to the Commonwealth and other countries. It was started up on July 3, 1948, and is expected to be in full operation by October, 1948.

Like the Gleep, the new pile is of the graphite-moderated air-cooled type, and consists of several hundred tons of graphite blocks in which a large number of cylindrical rods of uranium are arranged in a regular lattice. These rods are enclosed in aluminum casings and are cooled by air which is drawn in through channels in the graphite so as to remove the heat generated in the fission process. The hot air is discharged through a 200-ft chimney stack, but some of it will be used for heating the laboratories. The pile is surrounded by a concrete shield several feet thick, so that the whole forms a cube with faces 400 ft square. The operation of the pile is controlled by two sets of neutron-absorbing rods, one of which is adjustable so as to maintain a constant power level. The second set, which is operated pneumatically, is designed to shut down the pile automatically if overheating occurs, or if an undesirable degree of radioactivity is indicated by the monitors. Any failure in the electric power supply or in the air flow also causes these shutoff rods to be actuated.

In addition to the atomic piles, several machines are being built at Harwell for the acceleration of particles in connection with experimental work in nuclear physics. These include the cyclotron which is being erected in one of the larger hangars. This cyclotron, which is 110 in. in diameter, consists essentially of a magnet weighing 700 tons. Each pole of this magnet will carry six pairs of windings. In all, some 70 tons of copper will be used for this purpose and at maximum power the current consumption of the magnets will be 600 amp at 500 volts. The cyclotron will enable experiments on nuclear physics, such as at present can be carried out only at the University of California, to be conducted at Harwell. It is hoped that this apparatus will be completed by the end of the present year.

A 5,000,000-volt van de Graaf generator also forms part of the equipment of the establishment.

In addition, a new laboratory is being built for work on the chemistry of radioactive materials, and semipermanent buildings are being erected for carrying out metallurgical, health, and medical work.

An experimental plant is also being built at Harwell for the separation, by fractional distillation, of the carbon isotope of mass 13 for which there is a considerable demand. In addition, a small-scale electromagnetic separator for other elements has been built, while a much larger instrument of the same type is under construction.

A Health Physics Group has been formed for carrying out general monitoring and survey work, so as to check hazards to health and to advise on appropriate precautionary procedure.

Continuous Casting

A MACHINE that will make steel from the liquid phase to the semifinished shape is reported to have been jointly developed by the Republic Steel Corporation and The Babcock & Wilcox Tube Company.

The results, demonstrated in continuous casting of semifinished steel, were said in the announcement to open up important possibilities to the entire steel industry through increasing productivity and decentralizing production by simplification of apparatus and increasing the final yield of steel from the original melt. The new method and apparatus are considered a timely response to great economic pressure to serve areas locally. Interest in the possibilities of continuously cast semifinished steel is enhanced by current uneasiness over high break-even points and the doubled and tripled cost of new productive facilities.

The greatest single advantage of this process, according to the announcement, is that it removes from the conventional process of steelmaking the most massive and expensive parts of plants, such as equipment for ingots, soaking pits, and the blooming mill. Instead, continuous casting permits passing directly from the melt to semifinished sections ready for secondary mills with the result that not only is the capital cost for a

given output greatly reduced, but also maintenance and operational costs. The work accomplished to date makes it clear that for the production of relatively small quantities of steel, and particularly as a means of decentralizing steel production, this new development fills the requirements of low capital and low operational costs.

It is expected that the steel industry eventually will find continuous casting as much an essential part of its operations as does the nonferrous industry.

The unit casts two or three times per week, handling both carbon and alloy steels. A section of about 30 sq in. has been used in this work and is satisfactory for commercial use at a rate of 400 lb per min. It is expected that continued work on this section will add considerably to the rate. A mold for a cross section of about 45 sq in. is now under construction.

This unit is located at the top of a 75-ft tower to which steel is delivered from the company's regular electric furnaces, and is lifted to the top of the tower in a transfer ladle. There it is poured into an inductively heated holding and pouring ladle.

By watching the liquid steel in the mold by a mirror arrangement, the operators can see at all times whether the liquid surface is clean and the process functioning properly.

Shortly after the shell of the billet has been formed the steel contracts, and in so doing the billet shrinks away from the mold. The metal therefore is in contact with the surface of the mold for only a few inches, and only in this short distance can it lose heat to the mold by direct contact.

Proper cooling of the mold is essential and its importance increases as the casting rate is raised. The more rapid the casting rate, the greater the quantity of heat which must be absorbed by the surface of the mold.

It was found that a number of metals performed almost equally well as a mold material. The Babcock & Wilcox Tube Company has used $^1/_{16}$-in. steel, $^1/_4$-in. copper, and $^3/_{16}$-in. brass. It has been found that brass has definite structural and fabricational advantages.

Since continuous casting requires a slag-free steel, the steel is poured from the holding furnace into a tundish, designed to strain out the slag. From the tundish the steel flows into the mold. A preheated tundish has been used but a specially designed electrically heated one will be installed.

Below the mold the casting passes through an insulated chamber which arrests and controls the speed of further cooling.

Below this chamber is the withdrawal mechanism regulating the speed of movement of the steel billet. The casting then passes an oxyacetylene torch which travels down the billet a short distance while the billet is being cut to specified length which can be as much as 35 ft. The cutoff section of billet is lowered to a horizontal position by a cradle arrangement.

Results have indicated that ovals of special proportions are the most practicable cross sections to cast continuously. These ovals will readily go into a rolling mill for shaping into rounds, or can be rolled into flats.

Continuous casting meets fully established criteria of sound steelmaking practice and is said to have certain advantages over the conventional method. It allows faster cooling, which results in a fine and uniform crystalline structure with very little segregation. It offers less opportunity for dirt or other foreign material to enter the castings and, in general, the surface or the ingot will be freer of checking and scabs, and its interior free of entrapped slag.

Flexibility of the heat-withdrawal pattern means that it is easier to solidify the steel in the mold progressively from the bottom to the top. Although the mold is of uniform cross section, it approximates in behavior the big-end-up mold—the type used for the best-quality steels.

Ingots made by this method are cooled quickly and therefore tend toward a fine grain rather than columnar crystal structure. The billets may be as long as desired and have no taper.

Machine-Tool Industry

THE present state of the machine-tool industry in the United States was discussed by A. G. Bryant, president, National Machine Tool Builders Association, and vice-president, Cleereman Machine Tool Company, at the Machine Tool Sales Refresher Course, Cornell University, Ithaca, N. Y., recently.

Mr. Bryant pointed out that in the four years during the last war the machine-tool industry built more than one million machine tools. At the beginning of the war there were approximately one million machine tools in the United States. Therefore the industry approximately doubled the machine tools of the United States during the war. In that four-year period as many machine tools were built as had been built in the previous forty years.

A large percentage of these machines were government-owned and were disposed of as war surplus. The government disposed of hundreds of thousands of machine tools, many of them at prices ranging from 18 to 25 cents on the dollar of original cost. The impact of the surplus business upon the machine-tool industry was tremendous.

According to Mr. Bryant, that surplus now has been largely dissipated; there are no longer huge stores of surplus government-owned machines facing the industry.

There are, however, privately held stocks of used machines throughout the country, and there is still the effect of the surplus in a continuing stream as these machines are released in competition with the industry. But it is remarkable that the nation has absorbed so large a number of machines since the war, he said.

Many persons anticipated at the close of the war that the government would seize the opportunity to build up the potential defense of this country by setting aside a really sizable quantity of machine tools, thus saving great expense in the future and making possible quick activation of manufacturing facilities for the production of war goods. Unfortunately, Mr. Bryant stated, politics intervened and it took a long time for any kind of a reserve to be set aside. The government now has approximately 90,000 machine tools in the "JANMAT" military reserve. The ultimate objective is double that.

Mr. Bryant revealed that in 1942 the American machine-tool industry produced $1,322,000,000 in machine tools. That is tremendous when compared with the average of about $100,000,000 a year before the war, with peak volumes in 1929 and 1939 of about $200,000,000. The actual top rate of production in part of 1942 ran at the rate of nearly $2,000,000,000 annually.

From that level the industry reduced its capacity. It has sold out some plants; it has discontinued some sections of plants; it has finally gotten its over-all capacity down to an estimated $600,000,000. And last year, with a volume of output of $307,000,000, the industry operated at about one-half capacity.

A recent survey indicates that the industry has been operating in 1948 at just about the same rate of capacity as in 1947. In May there was a drop in new-order activity. However, there was a comeback during June. Reports indicated an expectation of a continuance at about the same general rate.

According to Mr. Bryant, in normal times 20 per cent of the volume of the machine-tool industry has been exported. Without that 20 per cent, the machine-tool industry is in a perilous position. It must have that business. In 1947, 26.6 per cent of the industry's volume was shipped abroad. At the present time, less than 10 per cent of the industry's volume is going

abroad. That is having a serious effect, particularly upon many manufacturers. It is just that difference in volume that makes the difference between profit and loss in many cases.

Mr. Bryant pointed out that the machine-tool industry, fundamental as it is, important as it is, is very small, consisting of only 200 companies. More than 50 per cent of the machine-tool builders of the industry do less than one million dollars' worth of business a year. Most of the companies have only a few hundred employees. They are small individual companies; they are not large aggregations. In 1947 the industry did in one year just about as much volume as General Motors did in one month. And it did less than General Electric did in one quarter of a year.

Human Bone Properties

RECENT developments in high-speed aircraft have caused flight personnel to be subjected to numerous shocks and impacts in ordinary flights as well as those encountered in accidents. This has made it increasingly important that safety devices be developed for the protection of the human body. It was apparent that in order to establish logical criteria for the design of these devices, a systematic and thorough study of the effects of impacts on the human body was needed. In conjunction with such a study being conducted by the Naval Medical Research Institute, the assistance of the National Bureau of Standards was requested when it was realized that progress in the investigations depended on close co-operation between the engineering and medical professions in order to cope with the mechanical as well as the pathological problems involved.

Research with human bones at the National Bureau of Standards has indicated that ordinary laboratory techniques and instruments may be applied to obtain the much-needed data on the mechanical properties of bone—knowledge necessary in predicting body behavior under impact loads as encountered in aircraft crashes, seat-ejection from aircraft, parachute opening, and exposure to blast. Preliminary but significant results have been obtained in these investigations.

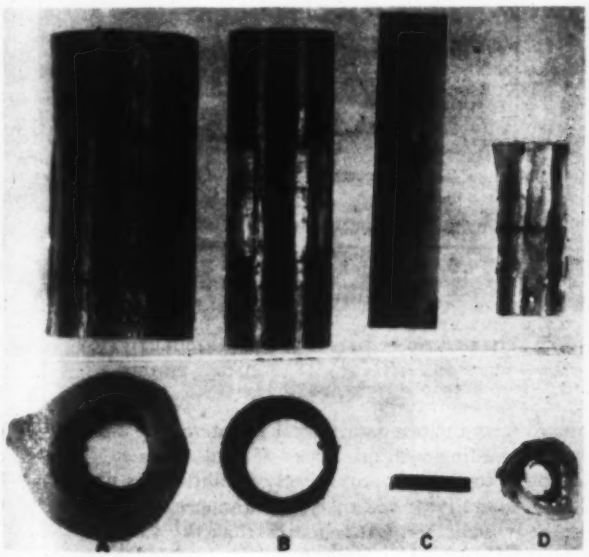

FIG. 4 PLAN AND END VIEWS OF COMPRESSION TEST SPECIMENS

(A and D, natural bones removed from bone shafts; B, tubular specimens machined into cylinders of uniform thickness; C, leaf specimens machined to 2.5 × 0.5 × 0.1 in. with the long dimension parallel with the direction of the bone fibers. The ends of the specimens were milled flat and parallel to insure uniform distribution of load under test.)

FIG. 5 TUCKERMAN OPTICAL STRAIN GAGES BEING ATTACHED TO TUBULAR BONE SPECIMEN PRIOR TO COMPRESSION TEST IN HYDRAULIC TESTING MACHINE

Many instances are known of aircraft and other vehicles crashing to complete destruction where occupants emerge from the wreckage miraculously unhurt. Conversely, a relatively slight blow to certain sensitive portions of the body may have serious and even fatal consequences. It has also been found that naval personnel have been seriously injured from exposure to blast or sudden displacements of ship's structure following the explosion of torpedoes, mines, or the firing of guns.

Since the human skeleton provides support for the body and protection for vital organs, it was decided to begin the study with an investigation of the mechanical properties of human bones and joints. Results are to be used in the design of simplified mechanical models of the human frame which will make possible an estimate of the forces set up in the body during impacts of various types.

The study was initiated with measurements of the mechanical properties of the structural members of the skeleton, beginning with long bones, and was designed to establish average values on a statistical basis. The initial work involved 17 tests on specimens made from bone of the compact type removed from near the middle of the bones of the extremities of humans and monkeys. Fourteen of these tests were made in compression with the direction of the load parallel to the fibers of the bone. One was made in compression with the direction of the load perpendicular to the bone fibers, one in bending, and another under torsion load. Test specimens consisted of sections removed from the bones, and of portions machined into plates and hollow cylinders, Fig. 4.

To obtain the mechanical properties of a substance it is necessary to know the compression or extension (strain) of the material for a given load (stress). Given the specimen's average cross section and the load, applied and measured in these investigations with a standard hydraulic-type testing machine, the stress on the specimen may be computed from elementary formulas of strength of materials. The strain in the bone specimens was measured with wire resistance and Tuckerman optical strain gages to an estimated accuracy of 0.000002 in. per in.,

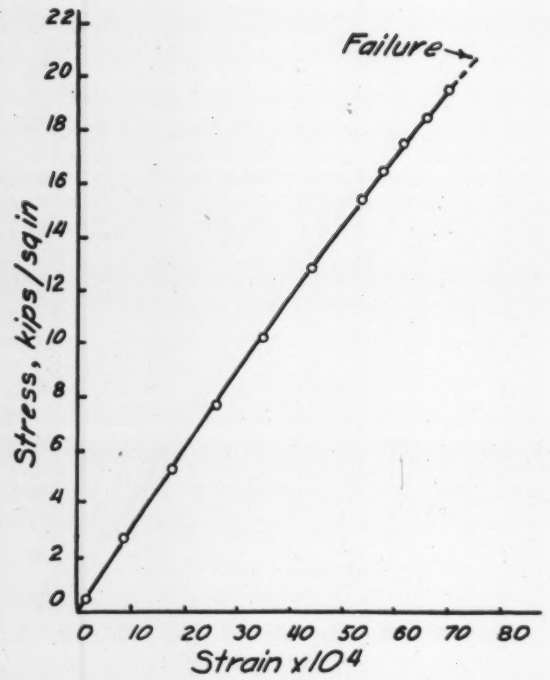

FIG. 6 STRESS-STRAIN CURVE OF SPECIMEN FROM HUMAN FEMUR

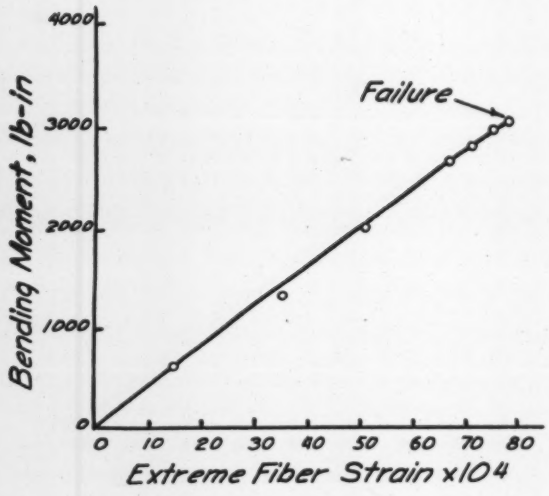

FIG. 7 BENDING MOMENT - STRAIN CURVE FOR SPECIMEN FROM HUMAN FEMUR

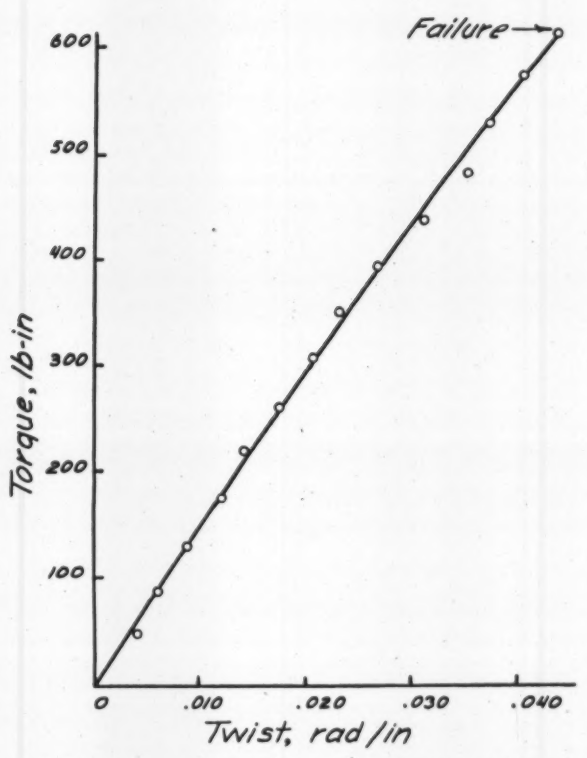

FIG. 8 TORQUE-TWIST CURVE FOR SPECIMEN FROM HUMAN TIBIA

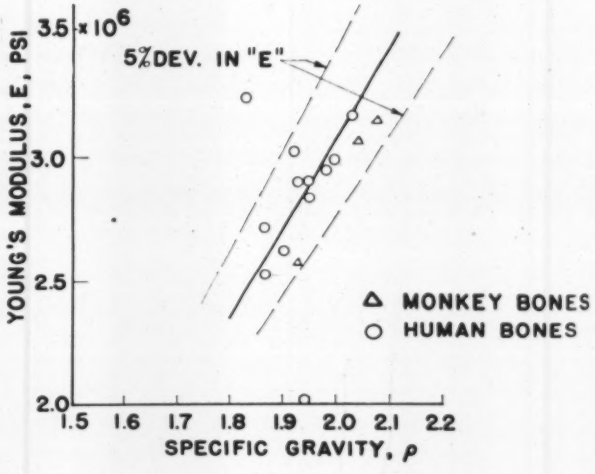

FIG. 9 CORRELATION OF YOUNG'S MODULUS AND SPECIFIC GRAVITIES FOR 16 SPECIMENS TESTED

Fig. 5. During the investigation simultaneous strain measurements using both types of gages showed that the electric strain gage could be used successfully on dry bones but would not function properly on fresh bone because of the inadequate bond between the gage and the oil surface. Earlier data obtained with this gage were corrected accordingly and all subsequent measurements were made with the Tuckerman optical strain gage.

The tubular compression specimens failed with a sudden snap and with longitudinal cracking, as did the bending and torsion specimens. The restraint of the special testing jig prevented complete failure of the leaf specimens.

Stress-strain, flexure, and torsion curves, Figs. 6, 7, and 8, plotted from the test data, reveal an interesting and significant factor regarding such properties of human bones. The curves are found to lie in approximately straight lines up to failure, thereby simplifying the analysis of the mechanical behavior of the body structure. This means that the load-displacement relations for long bones may be approximated by simple linear equations.

The results of the tests showed the average ultimate strength of the 14 compression specimens to be about 23,000 psi. The fifteenth specimen, in which the load was applied at right angles to the bone fibers, had about the same ultimate strength, indicating that the effect of the direction of loading on the bone is small. These strength values are in good agreement with those

reported by early German investigators. The strength of the bone in bending, i.e., extreme fiber stress at failure, was slightly lower than the strength in compression. The computed ultimate shear stress for the torsion to failure was about 15 per cent of the compressive strength.

These preliminary data indicate that bone may be considered an elastic brittle material having about one fourth the compressive strength of cast iron and more than twice that of hickory wood. The average Young's modulus of elasticity of the bone, about 2.8×10^6 psi, is approximately one tenth that of steel or about equal to that of wood. A simple relation was found between Young's modulus and the specific gravity of the bones tested, Fig. 9.

Plans for the next phase of the Bureau's program include compression tests of an entire human knee-joint in the "standing" position. Loads will be applied to the joint in a manner similar to that in which an actual joint is loaded while a person is standing, and measurements made of the consequent deformation of the joint. This test should provide some data on the "spring constant" of the joint, from which a mechanical analog may be constructed out of springs or rubber. Also under way is a study of the possible correlation between the x-ray absorption properties of bone and its strength and/or stiffness. Such a relationship would be useful in estimating the strength of living bone from x-ray data.

Man Power

THE general supply of man power is almost as tight today as it was at the peak of the war effort, according to a recent survey by the United States Employment Service appearing in the August, 1948, issue of the *Labor Information Bulletin*.

Most of the shortages are in the highly skilled occupations and professions centered around the construction, scientific, and some of the clerical and service groups.

The recent emphasis on scientific pursuits has been phenomenal, USES reports. Out of wartime research in nuclear physics, radar, electronics, and other fields, there developed a peacetime demand for scientific workers that has created a serious man-power famine.

Outside the field of science there are few occupations that are in absolute nation-wide shortage. However, the shift from wartime to peacetime industrial activities has been complicated by imperfections in the flow of labor from area to area. Consequently many local shortages have been created.

The man-power problems that accompany such unusual industrial activity are somewhat reminiscent of wartime conditions—in reverse pattern. There is a present need for skilled workers in the construction industries, for example, as compared with the wartime need for such workers in the metalworking industries. Artisans in the numerous service industries such as cabinetmaking and upholstering now find steady outlet for their talents as compared with a doldrum demand during the war.

Another reversal has been in the locations of the occupational needs. Many of the large defense plants were built in sparsely settled areas for internal security, safety, or other compelling reasons. Most of these units have since been abandoned or placed in inactive status. The prewar concentration of industrial plants in the Great Lakes, New England, and Middle Atlantic regions has largely been restored.

Also, the skill level of man-power demands has changed. Wartime tooling-up and expansion created and sustained a demand for many highly skilled men. After this supply quickly exhausted itself, golden opportunities in the war of lowered requirements and quick promotions gave impetus to the upgrading process. Today, on the other hand, there is relatively little hiring done on the higher skill levels. Rewards in the form of promotion from within have cut the opportunity for lateral transfers. Union apprenticeship and seniority standards have been rigidly re-established, so that partially qualified persons can no longer gain quick advancement through rapid shifting.

According to the USES survey, the tendency today is to start "at the bottom" rather than close to the top. Of course this development does not apply to some industries like construction where skilled men typically move from one job to another.

A final trend has been the replacement of women by men in many skilled and semiskilled jobs taken over by women in the wartime period. This trend was inevitable in view of the release of millions of veterans and the retirement of a great number of women from the labor market.

Construction leads off with many local shortages among bricklayers, carpenters, electricians, painters, plumbers, plasterers, and ornamental-iron and sheet-metal workers. In the service industries, numerous shortages are reported for auto body repairmen, automechanics, cabinetmakers, upholsterers, waitresses, and domestics. The apparel industry has needs for alteration workers, hand sewers, machine pressers, sewing-machine operators, and tailors. In the white-collar groups, frequent mention is made of shortages of stenographers, bookkeepers, and office-machine operators.

The metalworking industries need diemakers and setters, machinists, millwrights, patternmakers, spinners, toolmakers, molders, buffers, armature winders, and engine-lathe and milling-machine operators. The textile industry mentions loom fixers, twisters, weavers, and winders.

Finally, there are many opportunities for professional workers such as draftsmen; laboratory, medical, and x-ray technicians; nurses and pharmacists. Also needed are engineers, physicists, chemists, bacteriologists, and metallurgists.

Steam-Station Costs

THE Fifth Steam Station Cost Survey, made by A. E. Knowlton, Mem. ASME, senior associate editor, *Electrical World*, and appearing in the July, 1948, issue of that publication, states that interest in design of steam power plants is at a high pitch and justifiably so for several cogent reasons. More plants are being built than at any previous time. They are costing more to build. Fuel and man power are costing more.

To compile the report, data were sent in covering 113 stations, twice as many as for the Fourth Steam Cost Survey (1939) and well over five times as many as for the third survey.

POWER-GENERATION COSTS

According to the report, energy generated in representative USA power plants in 1947 cost nearly a half more than in 1939. A fair average across the country shows production costs ranging from as low as 1.5 and as high as 14 mills with an average value of 4.5 mills per net kilowatthour. Nine years ago the corresponding figure was approximately 3 mills.

The average cost of net kilowatthours at the bus for plants from 5000 to upward of 300,000 kilowatt rating in 1947 was about 7.5 mills. Since the average production cost appears to be 4.5 mills the fixed charges can be set down as 3.0 mills on the broad average basis.

So great was the load imposed in 1947 on installed capacity that only one in six of the plants was subjected to a peak below its rated capacity. Peaks were commonly up to 120 to 130 per cent of rated capacity. The efficiency at this loading may not have been optimum of course. The plant factor (ratio of actual net output to that obtainable over 8760 hours of full-rated ca-

pacity operation) was even more favorable. Except for the largest plants the national (sampled) average was about 70 per cent in 1947.

PLANT INVESTMENT

The survey indicates that a kilowatt of generating capacity has, according to detailed reports on 102 generating stations, cost as much as $200 and at one time could apparently be set up for as little as $46. The phenomenally low value can be accounted for by simplified design to take advantage of a very low fuel cost and by resort to outdoor installation of the boiler. The general average lies between $90 and $130 for plants operating in 1947, regardless of the age of the oldest operating unit.

The progressively larger plants, as would be expected, are on the average carried at lower costs per unit of rating than the smaller ones. In fact the very largest plants, even if quite ancient, represent lower unit costs than the middle-sized plants; the latter showed up advantageously, however, in over-all costs per net generated kilowatthour.

The plants of less than 60 megawatts built in 1920–1929 and not since expanded cost on the average about $150 per kilowatt. Those built in 1930–1934 averaged about $107 and those in 1935–1939 as low as $76. By 1940–1944 this unit cost had risen to $110 and by 1945–1947 had soared to about $135. Note that the 1947 unit cost had not quite reached what was experienced in the inflation and boom which lasted through the decade following the first world war. It is stated that the costs being experienced in 1948 in connection with new capacity are already reported to lie on an extension of the upward trend of the 1939–1950 cost.

Investment costs for plants of 60 to 149-megawatt rating built entirely within the 1920–1929 decade, averaged approximately $100 per kilowatt of rated capacity. By 1940–1944 the average had fallen to about $83 but by 1945–1950 it rose to about $113 per kilowatt.

Investment costs regardless of plant vintage indicate that the spread in dollars per kilowatt is much greater for small plants than for large plants.

The largest plants represent an average of $85 per kilowatt rating and the smallest about $120.

The boiler plant constitutes the largest component of over-all station cost. For a rough guide as to averages about all that can be safely said is that the structure and improvements for a $100 plant amount to $28, the boilers and their associated thermal equipment to $36 and the turbogenerator account to an added $26. All the office space, shop, electrical galleries, etc., account for the remaining $10. Actual departures from these rough approximations are quite wide.

PLANT FUEL ECONOMICS

The larger the station the better its thermal achievement. In fact, the largest plants as a group do a 60 per cent better job in using fuel energy to best advantage than the very smallest plants. However, there is much less spread in the groups above the 50-megawatt ratings. The spread within each group of ratings is wide enough, it seems, to warrant plenty of analysis toward narrowing the range and emulating the best. Of course the availability of very cheap fuel in some locations removes one sizable incentive to achieve superlative thermal performance. Note again that the plants between 150 and 200 megawatts do the best job of all, thermally speaking.

It is self-evident that higher boiler pressures and steam temperatures afford better thermal performance. The 1200 to 1600-psi plants hit below 11,500 Btu per net kilowatthour. The 800 to 1000-psi plants hover nearer 12,000. The 600 to 700-psi plants reflect about 13,000. Finally, the 200 to 400-psi plants range from 14,000 to 26,500. All the report data have been entered only for single-pressure plants.

Coal has reached $10 per ton for some utilities; it may represent close to 40 cents per million Btu. Some elsewhere can, on the contrary, get 1000 cu ft (over a million Btu) for as low as 5 cents.

FUEL, LABOR, AND MAINTENANCE

Plants of 60 to 75 megawatts show the highest production cost and those in the 100 to 150-megawatt bracket the lowest production cost. Those in the 75 to 100 group follow the natural trend downward from the smallest to the largest stations, the report states.

Fuel represents varying percentages of the total production cost of generating a net kilowatthour. For the small plants, many of which are favored by cheap fuel, it may constitute only 25 per cent. For the largest plants it may be up toward 80 per cent or even higher. Perhaps 70 per cent is not a bad figure for anyone prone to look for an all-inclusive average.

Wages and superintendence take a large chunk of the remainder, approximately 0.5 to 2 mills in the largest plants and only a fraction more in the moderate and small-sized plants. It can perhaps be set down as 20 per cent of the total cost of production as a broad over-all average.

All the remainder goes for maintenance labor, water, supplies, lubrication, engineering, etc. The total does not amount, on the whole, to much more than 10 per cent of the total production cost.

OPERATING STAFFS AND SPACE FACTORS

Large stations very definitely require fewer employees per megawatt of plant rating than the smaller stations, according to the survey. The spread is quite pronounced, being just above one employee per megawatt for stations of 100 megawatts and upward and practically two for stations of less than 20 megawatts.

The report states that the stations are being operated, on the whole, with slightly fewer employees than was the case 9 years ago. Some of this is definitely attributable to the establishment of new stations the design of which was aimed at minimizing the number of operating employees by advantageous configuration, location of control stations, etc.

It is shown that (at least for the plants above 60 megawatts) it takes roughly twice as many men, in general, to operate as to maintain the equipment. The very largest plants seem to reflect a greater proportion of employees assigned to maintenance than those of 200 megawatts and less rating.

Between 60 and 150-megawatt ratings the stations have been so designed as to devote a greater volume of structure to both boiler and turbine rooms than for stations larger or smaller.

Structural costs are so much higher relatively than equipment costs it is not surprising that every effort is being made to minimize the outlay for the building provided to house the working equipment.

Boiler Tubes Fouling

THE possible influence of phosphor on the external fouling of boiler tubes was summarized by Jean Valley, engineer, Brussels, Belgium, in a paper presented at the 1947 ASME Semi-Annual Meeting; Chicago, Ill. His paper was based on observations made of the boilers in various central electric stations serving France and Belgium.

About 1937 a fouling problem, where the deposits were particularly aggressive and adhesive, was encountered. In order to make a thorough investigation, a systematic analysis was made of deposit samples taken in various parts of the boiler, from the "birdnestings" on the furnace tubes up to the deposits

on the economizer tubes. The analysis, surprisingly revealed the presence of important quantities of phosphor, up to 40 per cent in weight of P_2O_5.

Trials on other boilers were made and on several occasions similar amounts of deposits were found.

The following two principal tendencies were evident: (1) The proportion of phosphor increases toward the rear of the boiler. It is low on the furnace tubes and high at the boiler exit and on the economizer; (2) the proportion of phosphor is higher in the inner part of the deposits (immediately against the tube wall). It is much lower on the surface.

In several of the cases the boiler water did not contain any particle of phosphates. The phosphor in the deposits therefore could not result from salts which might have been introduced in the combustion gases through leakage at the expanded tube ends. It could have found its origin only in the fuel.

The release of phosphor may occur, particularly with certain coals, during the preparation of the sample of ashes itself, and the results of the tests made on such a sample will be in error.

Whatever the error may be, its importance cannot justify the great difference between the amounts of phosphor existing in the ashes and that existing in the deposits on the tubes. It is therefore assumed that if the deposits contain a quantity of P_2O_5 ten, twenty, and up to one hundred times higher than the ashes, this is due, without doubt, to a concentration of phosphor on the tubes during the operation of the boiler.

In giving a plausible explanation of the observed facts, it seems rather difficult not to evoke a condensation phenomenon similar to that of the dew point on the economizer tubes. The burning coal releases phosphor, especially in boilers with grate stokers. The phosphates, which in air are highly resistant to decomposition by heat, decompose more quickly in a reducing medium. The decomposition starts at about 1300 C or even lower (850 to 900 C).

Both conditions exist during the combustion of coal; the silica being included in the coal itself. The reducing medium is provided by the predominating presence of carbon. As the combustion temperature is always much in excess of 1100 C, it is evident that all conditions are favorable for securing a rapid decomposition of the phosphates. This then, results in the release of a mixture of oxides of phosphor and pure phosphor, the latter being reoxidized as soon as it comes into contact with the excess air in the furnace.

Part of the volatile oxides thus formed condense on the tube, more readily at the rear of the boiler where gases and walls become progressively colder. This explains the first observed tendency. It may also be assumed that condensation is greater where the tube is cleaner and consequently cooler; this explains the high phosphor content in the deposits adhering to the walls of the tubes. This also explains their consistence—homogeneous and compact. This structure may be likened to that of the internal deposits of salts with a negative coefficient of solubility.

It is finally easy to explain the anomalies of certain analyses. Two different causes, it is thought, provoke the fouling of the heating surface: (1) The mechanical conglomeration of fuel particles on the tube's surface; and (2) the condensation of phosphorous gases emitted by the coal.

If the fouling is provoked simultaneously by the two causes, at the same point of the tube, deposits of quite different origins may be found. The composition of the solid particles, however, must not be very different from that of the ashes. The deposits due to condensation must be phosphorous. The analyses, as already indicated, may reveal considerable differences according to the way in which the two processes have been attacked, and also according to the way in which the sample has been taken.

The author states that although the fouling due to the condensation of phosphor was emphasized, the other causes of fouling have not been forgotten. It is considered that the formation of birdnestings as well as the soot deposits on the tubes are of mechanical origin and constitute a problem which can be more easily dealt with than that of the condensation of phosphorous gases. If such a condensation is admitted to be the real origin of fouling and the initial cause of a lowering of efficiency, it is to be considered as a prevailing problem whose effects should be carefully studied and then checked.

It does not seem easy to find a way of preventing the distillation of phosphor while all favorable conditions exist in the coal itself. At first sight it does not appear that any previous treatment of the fuel or the addition of a chemical body could alter this position. Only tests will settle this question.

Carbonyl-Iron Powders

BECAUSE of the widespread interest that has been aroused in carbonyl-iron powders as a result of an invention of a new magnetic clutch by Jacob Rabinow of the National Bureau of Standards, in which these powders are used (See "Magnetic Fluid Clutch," Mechanical Engineering, May, 1948, pp. 442–443), the following brief history and description of the powders has been prepared and appears in the August, 1948, issue of *The Journal of The Franklin Institute:*

Iron-carbonyl powders are manufactured by General Aniline and Film Corporation, Grasselli, N. J. The manufacture of these powders expanded rapidly to meet the heavy wartime demand for use as an important agent in various electrical devices, particularly in the field of communication, including radar, short-wave transmitters, carrier telephony, and in frequency-modulation devices. One major application is in the form of cores in high-frequency magnetic fields.

It is estimated that more than 90 per cent of all automobile radio sets constructed since January, 1947, are built with cores made from carbonyl-iron powders. They are said to have been accepted by radio engineers as the "heart of inductance (push-button) tuning." These cores have made push-button tuning in auto radio sets possible.

Carbonyl-iron powders are manufactured under rigid production control. They are made by the reaction of carbon-monoxide gas with iron-containing ores to form liquid-iron penta carbonyl. This liquid is then heated to a temperature where it decomposes into powdered iron and the carbon-monoxide gas is liberated. The results of this method are unique: iron penta carbonyl is obtained which is chemically pure, and the iron-powder particles formed by its decomposition are all minute spheres.

While the process of manufacture appears simple, the closest attention to details is necessary to insure a product whose characteristics never vary. To illustrate: the powders are never exposed to air, but only to inert gases; ammonia is added to the packing containers to check any possible action of moisture and carbon dioxide during storage and shipment.

According to the article, the new type of electromagnetic clutch has the automobile, aviation, marine, and farm implement people enormously interested.

Rabinow's development, based on his discovery that frictional forces between solid surfaces and certain types of fluid media can be controlled by application of magnetic fields, is being studied by engineers, and Rabinow's visitors at his laboratory in Washington include representatives of the major automobile companies and clutch manufacturers.

ASME TECHNICAL DIGEST

Substance in Brief of Papers Presented at ASME Meetings

Railroad Passenger Comfort

Thermal Environment of Railroad Passenger Cars, by K. A. Browne, Mem. ASME, and S. G. Guins, Jun. ASME. Chesapeake and Ohio Railway Company, Cleveland, Ohio. 1948 ASME Semi-Annual Meeting paper No. **48—SA-45** (mimeographed; to be published in Trans. ASME).

Appreciating the limitations imposed by conventional railroad heating and air-conditioning equipment on thermal environment from the passenger viewpoint, the Chesapeake and Ohio Railway undertook a research program to develop means for improving substantially the thermal comfort in cars. Various controls and their components were investigated and radiant panel and floor heating and cooling were tested in a car in the Budd Company cold room and on the road. Then the car was completely re-equipped with means for accomplishing the objective and put into service test. It features effective control of humidity in the summer, no recirculating air in the overhead system, forced-convection heating and cooling panels, low-temperature gradients, and lack of draft.

It was found that the induced air circulation through the wall panels on each side of the car produces a definite flow up the walls and over the ceiling, producing a downflow in the aisle area, which parts at the floor and moves across the floor at 10 to 20 fpm and into the heating surface at the wall. The effectiveness of this circulation was unanticipated and it was found unnecessary to supply additional heat in the pipes under the floor. This was effectively demonstrated during the test, when one side of the car had no heat supply and the other side was carrying the entire load. The heated side showed a floor temperature of only 3 F higher than the unheated side and both maintained at a comfortable level. This circulation is said to be unnoticeable as a draft to passengers anywhere in the car, although there is a local draft over the window glass which can be felt if the hand is placed near the glass.

The system produces a drier air which results in improved car-space conditions, even at space temperature of 80 F.

The feel of thermal environment is definitely improved over that of the conventional system where all cooling load is handled by an overheat system of opposite circulation, and heating is handled by "hot boxes" along the floor.

Visual Passenger Comfort, by Brooks Stevens, Brooks Stevens Associates, Milwaukee, Wis. 1948 ASME Semi-Annual Meeting paper No. **48—SA-46** (mimeographed; to be published in Trans. ASME).

In general, the limitations that must be considered in the design of railroad passenger equipment and the styling of locomotives are the materials involved, initial costs, safety, maintenance, traffic handling, legal complexities, tradition, and obsolescence.

The more modern trains today have fallen roughly into two categories, namely, the bright stainless-steel treatment, fluted or otherwise, and the painted steel car.

It is pointed out that infinitely more individual identity and passenger appeal can be injected into the railroad-car paint styling today.

Safety must certainly come into the industrial designer's approach to the problem. His goal is to intrigue and please the passenger with the equipment, but it should not be at the expense of their safety and well-being. Many dangers lurk in the more aesthetic ways of styling lounge cars, diners, and even coaches. With the high speeds of today, we have sway despite our great improvements in riding qualities and suspension design. People may still be thrown against bulkheads, partitions, and furniture. One must be tremendously careful with the use of glass, sharp-cornered appendages, doorways, and the like. It is on important matters such as these that the designer depends heavily upon the experience and knowledge of the operating departments and the carbuilders' engineers.

Great care must be given to seating comfort and interior design to minimize the risks of dissatisfaction, complaint with regard to lounging facilities, food and beverage serving, attendant behavior, and the like.

The passenger of today is not going to be satisfied with drab, monotonous, purely mechanical interiors that represent the zenith in fabrication simplicity and maintenance ease. The dark glossy woods of the past, with the shiny layer of varnish, drab plush fabrics, and "busy" flowered-rug patterns, have given way to a greater use of color, woven patterned fabrics, simplified patterned carpeting, rubber tiles, linoleums, and individuality in color schemes between cars. Lounge areas for women can take on an individualized, feminine appearance, or the powder-room atmosphere, and for the men, the denlike masculinity of the club.

Railroad-car equipment today can borrow, in a sense, from two other sources appealing to the passenger—the home and some of the brilliant styling of the motorcar.

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Lighting can play a most important part in the interior aesthetic scheme, both from the standpoint of function and decoration. In connection with light and vision, increasing the size of windows and minimizing the width of intermediate pillar posts will continue.

In lounge and club cars today there is a tremendous opportunity for individual styling. Seating need not be regimented with chairs lined up on both sides of an aisle, but can be arranged in the smartest restaurant and night-club groupings, with changes in fabric and color schemes, so planned as to offer privacy, different-sized groupings, and even improved scenery appreciation.

Dining cars can also take on a higher degree of style and cleverness in design as compared to the standard coaches. Again, the regimentation of conventional seating can be varied for more interesting effects to increase scenic vision and the accessibility for entry and exit.

In the sleeping car of tomorrow the designer must work with the usual limitations of space and flexibility, but with a definite goal of creating a pleasant, individualized interior and a definite departure from the cell-like appearance of many cars today. In the room car of tomorrow each room could have its own color scheme, fabric patterns, and pictorial theme.

Berth mechanisms will be simplified and improved, the use of folding individual chairs is becoming more popular, and toilet facility annexes are a welcome reality. Observation lounge-car areas can be treated in very much the same manner as a club car, but with even greater emphasis on vision.

Decibel Level, by W. A. Jack, Johns-Manville Corporation, New York, N. Y. 1948 ASME Semi-Annual Meeting paper No. 48—SA-47 (mimeographed; to be published in Trans. ASME).

Originally the passenger sought transportation at a speed faster than walking. Given a mode of travel which he knew to be as fast as possible for the age, or as fast as his purse would allow, he began to be interested in other aspects of the conveyance than its mere speed. The railroad passenger of today knows that modern techniques and materials are available to give him transportation in comfort. Whether he chooses instead to use an airplane, bus, or private automobile depends on the facilities available, the ease and pleasure with which he can use them, and the cost to him in time and money. Competition between the different types of transportation and between operators of the same type makes it pertinent to examine all phases of the demands of the traveling public. The average passenger may consciously want something that he knows about, such as a comfortable seat like the one at home, or he may be won over by something demonstrated to him that he had not particularly thought about, such as a train ride superquiet by present standards.

This paper is partially concerned with mechanical vibrations, but only for those higher than 30 cps. Air-borne sound caused by them, when heard by the passenger, constitutes a portion of the acoustical problem. At frequencies lower than 30 cps we are in the region of the riding-comfort problem. Not all air-borne sounds come from mechanical vibrations, but are formed directly in air. By ordinary standards, the amplitudes of mechanical motion which generate troublesome sounds can be very small. Because of this the remedy usually does not lie in the field of closer tolerances but the problem can be controlled by certain techniques of the acoustical engineer.

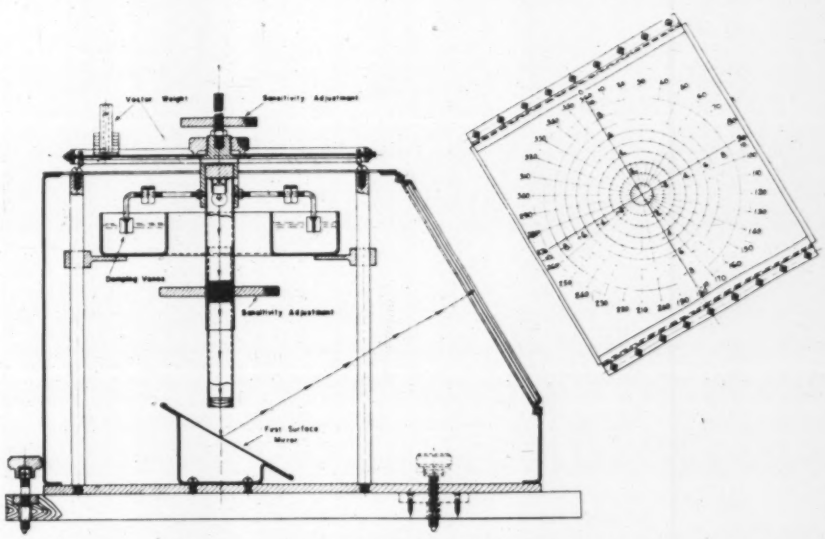
Air-borne sound is generated underneath the coach by rolling and jumping of wheels on rails, bumping in the spring-truck system, auxiliary units, such as a compressor, and wind noise; at the ends of the coach by couplings, loose vestibule doors and latches; inside the coach by vibration of all interior surfaces, ventilation system, loose fixtures, leakage sounds from any outside air-borne source. There are many possible ways by which the sound level which the passenger hears is built up. Acoustical theory and experience demonstrate that all important components must be controlled to obtain a significant noise reduction. There is no attempt in this paper to compare different types of coaches. The figures presented are from rather extensive investigations but are used in an illustrative rather than a comparative way.

Oil and Gas Power

Improved Techniques in the Study of Engine Firing Orders Using the Vectorscope, by G. J. Dashefsky, Mem. ASME, New York Naval Shipyard, Brooklyn, N. Y. 1948 ASME Oil and Gas Power Division Meeting paper No. 48—OGP-1 (mimeographed).

The state of dynamic balance of an engine and the magnitude of minor orders of torsional vibration are greatly influenced by the firing sequence of the cylinders. Investigation of this problem requires the evaluation of large numbers of vector diagrams and is therefore adaptable to the use of the Vectorscope. This mathematical instrument automatically and rapidly adds vector quantities with about the same accuracy as a good graphical summation. This paper deals specifically with techniques involved in applying the Vectorscope to the study of firing orders. Methods are indicated whereby large numbers of firing orders may be examined expediently and rapidly.

It has been found possible with the aid of the Vectorscope to handle engines up to 9 cylinders. The investigation of all of the firing orders of a 10-cylinder engine is believed to be feasible, although so far



DIAGRAMMATIC VIEW OF VECTORSCOPE

only some 30,000 of the 181,440 firing orders have been investigated for primary and secondary moments. An 11-cylinder engine has so many possible firing orders as to involve a prohibitive amount of work for a complete study. The Vectorscope does, however, permit the rapid selection of some better firing orders by a trial-and-error procedure. The nature of the Vectorscope is such that it serves as a visual aid in the selection of good crank arrangements, by manipulation of the weight representing the importance of the cranks.

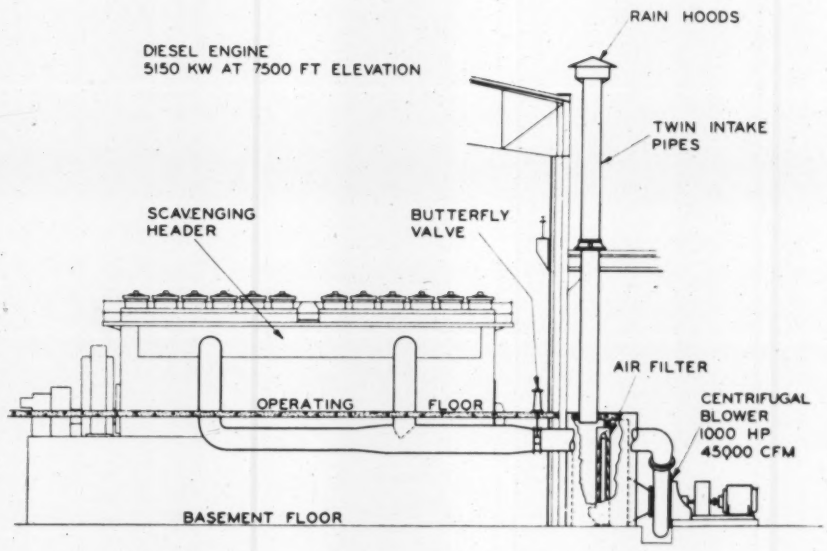
The instrument consists of a disk effectively pivoted at its center in a Cardan Suspension or on a single pivot bearing. Pegs to receive weights proportional to the vector magnitudes are distributed around the disk in the same angular orientation as the vectors to be added. An adjustable pendular weight provides the equilibrating moment for the disk-and-weight system and also a means for controlling the sensitivity of the instrument. The optical system carried by the disk projects a lamp filament focused as a spot of light on the screen, indicating the position of equilibrium of the disk. The displacement of the light spot from the zero position represents both magnitude and direction of the resultant vector.

Use of a clear glass screen permits marking the projected points upon translucent paper placed thereon. Adjustment and calibration of the Vectorscope are accomplished by placing a sheet of polar co-ordinate paper on the glass top. The weights representing vectors are made up by placing the weight carrier upon one of the pegs and adjusting the amount of weight to give the required deflection. The actual weight is of no importance. Sensitivity of deflection is controlled by the vertical position of the pendular weight.

Centrifugal Blowers for Two-Cycle Diesel Engines, by Robert Cramer, Jr., Mem. ASME, Nordberg Manufacturing Co., Milwaukee, Wis. 1948 ASME Oil and Gas Power Division Meeting paper No. **48—OGP-2** (mimeographed).

In spite of the less favorable efficiency and pressure-volume characteristic, the motor-driven centrifugal blower has found its place in recent years for use in scavenging two-cycle Diesel engines.

When an additional engine is installed into an existing powerhouse either in place of an older engine or in other available but restricted space, it has been found possible to include one or two additional cylinders in the space which would be occupied by the scavenging pump or gear-driven blower. The centrifugal blower may be located in a smaller structure outside the main powerhouse.



SCAVENGING-AIR SYSTEM FOR 29 × 40-IN. TWELVE-CYLINDER DIESEL ENGINE

For very large engines, especially with large numbers of cylinders, a much better distribution of scavenging air is possible than with the engine-driven blower or pump located at one end of the crankshaft.

In studying the interrelation of centrifugal blower and Diesel engine it is important to realize that both speed and conditions at blower inlet are variable as volume and density change. Characteristic curves must be constructed for the unit as installed, allowing for increasing resistance in the intake system with increasing volume, and also decreasing motor speed with increasing horsepower. Both of these factors increase the droop of the blower characteristic curves. Fouling of engine and fouling of the blower vanes by dust and oil must also be taken into account.

For most efficient operation the air volume of a two-cycle engine could decrease as the load decreases, but no available air source has this characteristic, with the possible exception of an exhaust-driven supercharger. The characteristic of positive-displacement blowers and pumps is very steep, i.e., the volume delivered is almost independent of changes in engine resistance or atmospheric conditions. The power required is affected only by atmospheric density variations.

The characteristics of the centrifugal blower are less favorable and because it is necessary to select the blower for the 90 F, minimum barometer, maximum-load condition plus allowance for engine and blower fouling, it is also necessary to limit the blower power at high density (cold air) and minimum-load conditions to maintain reasonable fuel consumption and to avoid overloading the motor. This is most conveniently done by throttling with a butterfly valve.

The throttling valve may be located in either blower suction or blower discharge. It is usually located in the discharge because it is more readily accessible to the engine operator. Automatic control has not been found necessary. Generally, the adjustment is mainly to compensate for atmospheric temperature variation and a conveniently located ammeter to show motor current is a rough but reliable guide to throttle setting.

When centrifugal blowers are driven by direct-current motors, as in marine installations, some compensation for atmospheric variation may be accomplished by variable-speed control.

While the motor-driven centrifugal blower is not the most efficient source of scavenging air for a two-cycle Diesel engine, its use has provided one solution to the problem of installing maximum additional horsepower into a restricted space. When the blower is properly proportioned and its peculiarities are understood, it is a very satisfactory source of air.

That the motor-driven blower is economically justified is proved by the fact that the author's company has installed or under construction, since the end of World War II, Diesel-engine installations in excess of 170,000 hp employing motor-driven blowers.

Diesels in Industry, by W. T. Watt, Mem. ASME, *Industry and Power*, St. Joseph, Mich. 1948 ASME Oil and Gas Power Division Meeting paper No. **48—OGP-3** (mimeographed).

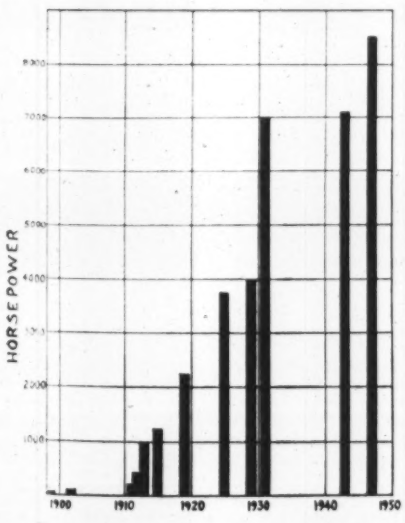
This paper portrays historical developments of the Diesel industry in its first 50 years and covers some of the outstanding applications of Diesel engines in industrial service. Technical developments and progress are not reported in detail, but are covered only because of their influence on market development or because they established new marks of progress.

Adequate historical data on the industry are difficult to secure. As is often true, statistics were not considered important enough to be recorded in the early years. Government figures are only fragmentary and do not recognize nor give any data on Diesel engines until 1921. Considerable variance exists between Department of Commerce figures on production and the industry's own figures as reported to DEMA.

Because published figures are not complete or consistent, the author has attempted to co-ordinate and correlate to some degree, the production and installation data reported at various stages, and to make the picture as complete as possible.

This approach results in an unusually long and detailed paper, but it was followed in the hope that it might develop a reliable basis upon which to record future growth and with which future progress might be compared.

NUMBER OF DIESEL-ENGINE MANUFACTURERS IN U. S.



MAXIMUM ENGINE SIZES PRODUCED

Diesels on Salt Water, by Walter L. Green, Mem. ASME, American Bureau of Shipping, New York, N. Y. 1948 ASME Oil and Gas Power Division Meeting paper No. **48—OGP-4** (mimeographed).

In 1912 the building at Copenhagen of the "Selandia" by Burmeister and Wain attracted the attention of the marine world as the first application of Diesel-engine propulsion to a full-powered ocean-going vessel of large size. Its machinery was of the single-acting four-stroke-cycle air-injection type with as much as possible of the auxiliary machinery attached to and driven by the main engine. Its economy and reliability in service established the internal-combustion engine as a competitor of the then almost universally used steam reciprocator.

As a major result, research aimed at development of the Diesel engine ensued all over the world

Statistical records show that by the end of 1930, in the comparatively short period of 18 years, out of the total world fleet of 9453 seagoing merchant vessels of 1000 gross tons or larger, those using the internal-combustion engine for main propulsion amounted to 1115 or almost 12 per cent of the total. By the end of 1939 the ratio had changed to 2175 Diesel-propelled out of a total of 9161, or amost 24 per cent.

During this nine-year period the average size of vessel had increased from about 5400 gross tons to about 5700, with a total increased carrying capacity for the world fleet of about 1.6 per cent. Statistics are neither available nor trustworthy on actual speeds of vessels as operated in service. It is more than probable, however, that this tonnage maintained at least 10 per cent greater sea speed than that of 1930. This would raise the effective carrying capacity of world shipping on a ton-mile basis and further enhance the proportion of cargo carried in the Diesel-driven fraction of the fleet, as that fraction constituted so large a part of the new and fast tonnage frequently operated at 30 or 40 per cent higher speed than did the obsolete tonnage it replaced.

Statistics for the ensuing period to the middle of 1946 reflect the impact of World War II. As of June 30, 1946, there existed in the world 12,445 ships of which only 2224 were propelled by internal-combustion engines, approximately 18 per cent. Primarily responsible is the fact that the Diesel-engine facilities of the world had been pre-empted for military and naval projects. The landing-craft program in this country alone absorbed possibly 30 million horsepower.

The American Diesel history, lines of development, fuel and lubrication cost, reliability, repairs, and personnel problems, and prospects for the Diesel engine, are covered.

Diesel Application on the Inland Waterways, by Arthur R. Parson, St. Louis Shipbuilding & Steel Co., St. Louis, Mo., and Donald T. Wright, *The Waterways Journal*, St. Louis, Mo. 1948 ASME Oil and Gas Power Division Meeting paper No. **48—OGP-5** (mimeographed).

A brief outline of the history of river transportation through the packet-boat and steamboat eras, with a description of modern towing practices and the use of Diesel-powered equipment on the inland waterways is given.

The history of the Diesel engine on the river parallels very closely the history of modern river transportation. A semi-Diesel boat was built in St. Louis about 1914, and a number of small semi-Diesel boats appeared on the rivers about 1917. This is about the time of the beginning of the lock-and-dam program, the inauguration of the Federal Barge Line, and other stimuli to river traffic.

The early Diesel towboats were of the stern-wheel type, the builders merely installing the Diesels in lieu of a steam engine, and using reduction gears to reduce the engine speed to suit the slow speed of the paddle wheels. The majority of these early Diesel boats were of small horsepower, rarely over 100 hp, and usually had wooden hulls.

With the river improvements came the need for more horsepower, and with it the need for handling larger tows upstream. The propeller-type Diesel boats are far superior to stern-wheel boats in handling tows going ahead.

The early Diesel boats of 100 hp to 200 hp were large enough for sand and gravel operators and for towing in canalized rivers; but the horsepower of the Diesel boats increased as did the percentage of Diesel boats built. The principal reason

for this change was lower operating costs and lower initial investment. Also, in many cases, the Diesel could be put on a smaller hull.

The river transportation was not expanding very rapidly between 1925 and 1933, and few large Diesel boats were built. With the coming of the depression, the need for low-cost transportation, and with the completion of the locks and dams, river transportation began to grow and is still growing. Beginning in about 1935, more and larger Diesel towboats have been built every year with the exception of the war years when very little river equipment was constructed.

In 1938 the first commercial river towboat was built with an air-conditioning system built in. Since that time, although a number of boats have been air conditioned, the practice has not become universal.

In addition to air conditioning, many other improvements have been made on the interior finish and furnishings of the modern towboats, until in every respect they are equal to the finest hotels.

At the end of the second world war, with the experience obtained during the war with various types of supercharging and other advances in design, the Diesel builders were able to deliver more than 800 hp without increasing the size of the engines. Today towboats are built with 1600-hp engines on each propeller shaft.

There are a number of single-screw and twin-screw towboats in operation today using engines of about 1600 hp at speeds up to 800 rpm and using reduction gears. The use of reduction gears is a new practice, as before the war there were only a few large towboats on the river using higher-speed engines and gears. This was mainly because the gears used before this time were not sufficiently strong to withstand the rugged operating conditions.

There are about 9500 barges and 1250 towboats engaged in river transportation today. Of these 1250 towboats, 983 are Diesel-powered, and 267 are steam-powered. Of the 267 steamboats, only 23 have been built since 1939. This includes the 21 steamboats built for Defense Plant Corporation during the war when Diesel engines were not available.

In addition to a number of towboats being built "on the bank" by their owners, there are under construction in the shipyards, for river use, 22 Diesel towboats with a total of more than 34,000 hp.

In 1947 there were 34 Diesel towboats built for use on inland rivers with a total of 34,050 hp.

Calculation of Torsional Vibrations in Engines, by A. W. Hussmann, North Caroline State College, Raleigh, N. C. 1948 ASME Oil and Gas Power Division Meeting paper No. **48—OGP-6** (mimeographed).

Numerous methods have been proposed to solve torsional-vibration problems. However, the classical Holzer method is commonly used, especially in this country, and therefore familiar to the average engineer. The following paper shows how almost all other numerical methods can be understood by Holzer's principle and can be calculated in the same tables.

The conventional Holzer tabulation is rearranged to facilitate numerical calculations. Formulas are given for converting the given systems into dimensionless systems. The basic table for a discreet mass system is extended to include continuous masses or homogeneous units of (m) equal masses. All relations are given to calculate systems with damping in the same tables.

As used, the Holzer method is a trial-and-error procedure. The calculation is carried out with an assumed trial value of the frequency λ and is repeated with other trial values until given boundary conditions are satisfied. It is shown in the paper that by calculating only once through the table with an algebraic value of λ, the frequency equation can be written as a series in powers of λ. The solutions of this equation provide all possible natural frequencies.

By applying the same principle to the extended table for systems with continuous masses or homogeneous units the frequency equations can be readily set up for these systems also.

Aircraft Anti-Icing

What Is an Optimum Anti-Icing Design? by R. L. Berner and T. H. Grieger, The Glenn L. Martin Company, Baltimore, Md. 1948 ASME Semi-Annual Meeting paper No. **48—SA-38** (mimeographed).

Performance characteristics constitute one of the major preliminary concerns in the planning of an anti-icing design. Likewise, a knowledge of the number of engines which are normally used in any maneuver is required, particularly if their use as a heat source is anticipated. Also of prime interest are the physical characteristics of the aircraft. The peculiarities of construction, particularly of the leading edges, and any conflict with existing or proposed installations should be noted. Of greatest importance is a knowledge of the airfoil angles of attack under all flight conditions. Last, but of no less significance, are the specifications for the anti-icing system. These establish the standards for performance, safety, dependability, etc., and become a constant guide for the designer.

An anti-icing system with the usual number of switches valves, thermostats, etc., is under consideration. The specification requires that failure of the anti-icing system to provide adequate protection shall occur on the average of no more than once in 30,000 hr of flight. Analysis indicates that the compounded factors of the foregoing equipment items yield a failure factor of one time in 800 hr of flight. Other data establish the likelihood of encountering the specified icing condition as once in 500 hr of flight. Thus it may be shown that the probability of system failure is but once in 40,000 and that precautionary measures are unnecessary.

Basic anti-icing specifications, being the only factor in common with all applications and being at the source of most design problems, seem to offer one of the most promising sources for improvements.

Subjects such as design problems, why an optimum design, and corrective measures are discussed.

Heat Anti-Icing for the Airlines, by David North, American Airlines, Inc., Tulsa, Okla. 1948 ASME Semi-Annual Meeting paper No. **48—SA-40** (mimeographed).

The future of the airlines depends upon their ability to provide the traveling public with good transportation. One of the many things that the public wants in air travel is an increased feeling of security and safety while flying during stormy weather. The occasional presence of aircraft-icing conditions has contributed to schedule irregularities in air travel during the past few years.

This paper discusses warm-wing anti-icing, icing characteristics of airplane propellers, and parasitic ice formations.

Thermal wing anti-icing has passed its proving tests and has become a significant factor in improving the ability of airlines to provide all-weather service.

Propeller deicing with leading-edge heated elements is making progress, although not yet perhaps quite up to the standards of wing protection.

The design criteria for protection from carburetion ice are well-established.

The heating of windshields is moderately successful in many aircraft.

Parasite ice formations on engine cowl

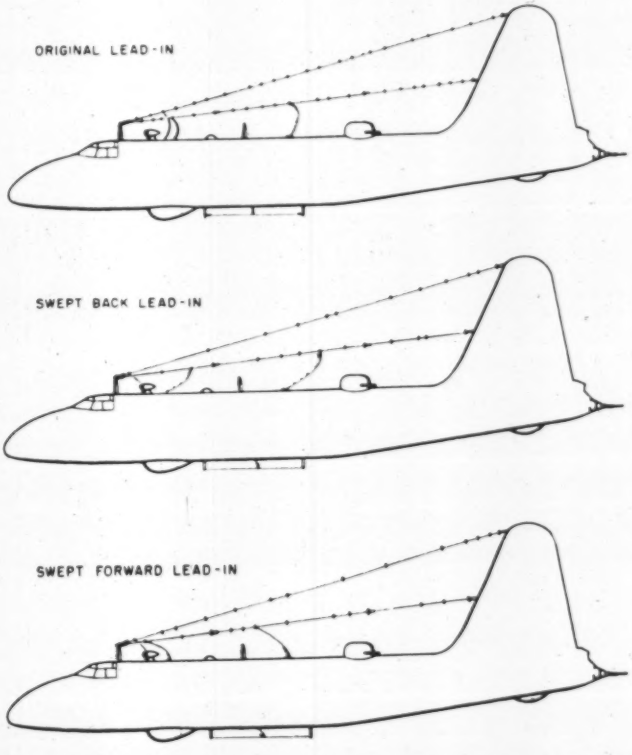
ing, propeller domes, miscellaneous air-scoops, antennas, etc., need much constructive thought and corrective action in order to remove the attendant hazard of prolonged icing flights.

It is pointed out that the airlines need a simple inexpensive device for accurately measuring the important dimensions of liquid-water content and drop size of ice-producing clouds so that all icing reports can be compared to a common standard of measurement for future design of heat anti-icing systems.

Icing Flight Tests of the Lockheed P2V, by R. L. Thoren, Lockheed Aircraft Corporation, Burbank, Calif. 1948 ASME Semi-Annual Meeting paper No. 48—SA-41 (mimeographed).

The Lockheed P2V has been flown in various types of icing conditions from light rime to moderately heavy clear ice to determine the effectiveness of the heat anti-icing provisions for this type of aircraft. The most severe icing condition encountered was a flight of two hours' duration in a freezing rain. Considerable information was obtained relative to the effectiveness of the heat anti-icing system for the wing and tail, permitting a comparison to be made with the original design requirements. Information was obtained relative to the efficiency of the carburetor and propeller anti-icing provisions. Radio operation was studied during icing conditions and other conditions conducive to precipitation static. Improvements were made to the antenna system to provide a greater degree of protection against ice. Protection of the ramming-type fuel-tank vents against ice formation was afforded by streamlined "ice-catching bumps" located ahead of the fuel-tank vent scoop and this setup was found to be satisfactory. Ice formations on unheated parts of the airplane such as the fuselage, wing center section, and nacelles were found to contribute considerably to the over-all drag of the airplane. Frozen runback, due to insufficient evaporation of the moisture hitting the leading edge of the wing and tail, was found to occur over certain portions of these respective surfaces, and the runback was found to occur in rivulets building up to appreciable thickness behind the heated leading edges. Precipitation static under certain atmospheric conditions was found to make the radio practically inoperative. Although the scope of this investigation was not particularly extensive, it was determined that heavy icing conditions occurred relatively infrequently, and moderate icing conditions generally occurred over relatively small areas and altitude ranges. No flights were made in ice at low air temperatures such as 0 F or lower; hence the actual performance of the system under these conditions has not been determined.

Some of the conclusions reached are as follows: Horizontal tail deicing is satisfactory, vertical tail marginal, and some portion of the wing is marginal; propeller deicing is satisfactory; protection of the carburetor against icing is satisfactory; slanting the antenna lead-ins 45 deg forward and upward from the top of the fuselage provides some degree of protection against loss due to ice; suitable protection has been provided the fuel-tank vents in the form of streamlined bumps located ahead of the vent scoops; the air-speed system is satisfactory for service; operation in snow under low air-temperature conditions may present problems; and if sufficient ice forms on the radome, malfunctioning of the radar will occur.



TYPICAL ICE FORMATION ON RADIO ANTENNA

Fuels

Fuels Performance at Port Washington Station, by W. A. Pollock, Wisconsin Electric Power Company, Milwaukee, Wis. 1948 ASME Semi-Annual Meeting paper No. 48—SA-7 (in type; to be published in Trans. ASME).

This paper contains recent operating data, a discussion of relevant design features, and information comparing prewar and postwar coals as affecting operation of the Port Washington Station of the Wisconsin Electric Power Company. In order to make the report complete, fuels and station performances are presented.

A relatively cool furnace, and the storage system of burning pulverized coal are shown as big factors in sustaining reliability and economy as daily station output is increased.

Operating data and other often-requested data of general interest are presented.

A comparison is made of prewar and postwar coals, including some figures on extras needed because the postwar coal has had a lower heat value and higher ash. More maintenance chiefly to the pulverizers and the draft fans has been shown to result because of poorer qualities of the 1947 coals.

Development in Milwaukee of Burning Pulverized Coal, by F. L. Dornbrook, Mem. ASME, Wisconsin Electric Power Company, Milwaukee, Wis. 1948 ASME Semi-Annual Meeting paper No. 48—SA-57 (mimeographed).

This paper is a review of the history of

burning pulverized coal as applied in Milwaukee and recalls some of the early experiences and outlines the developments up to the present date. The methods adopted by the Milwaukee Company are used as a result of experiences extending over thirty years. No claim is made that these methods are the only ones possible but they have been successful and efficient when applied to Milwaukee conditions.

When faced with higher coal costs and a question of what kind of stoker should be selected to burn every kind of coal, it was thought that better results could be obtained if all coal were burned in a pulverized form. That was the birth of a trial installation on one boiler in the Oneida Street power plant in Milwaukee early in 1918, and shortly afterward on four more boilers.

By November, 1919, it was possible to perform tests on the five boilers, each of 468 bhp, burning a mixture of pulverized screenings. A test of 99 hours' duration, or a total of 495 boiler hours, showed a gross efficiency of 80.6 per cent.

In 1923 the Bureau of Mines published the results of a series of 38 tests made between June and December, 1920, in its Bulletin 223.

These tests showed that a coal fineness of 80–85 per cent through 200 mesh was unnecessary and that fineness of 60–65 per cent through 200 mesh for coal being used was practically efficient. This permitted high capacities of mills and lower costs of preparation.

In 1919 a decision was made to fire the eight boilers of the new Lakeside power plant with pulverized coal. For Lakeside, the storage system, sometimes called bin and feeder system, was adopted on the basis of the experimental installation at Oneida Street.

In 1925 the Bureau of Mines published the results of a series of 26 tests made during the period of May, 1921, to October, 1921, in its Bulletin 237. Efficiencies of boiler, superheater, and economizer were reported from 84 to 91 per cent.

In 1923 the company added eight boilers of 1828 bhp and 300 psi each to serve three additional turbogenerators of 30,000 kw each at Lakeside. These new boilers had larger furnaces and were provided with screen tubes at the bottom of the furnace connected into the boiler circulation system.

In the period of 1926 to 1930, the company installed at Lakeside four 300,000-lb per hr 1200-psi boilers with radiant superheaters and reheaters. The mills were placed adjacent to the boilers in the boiler room for convenience.

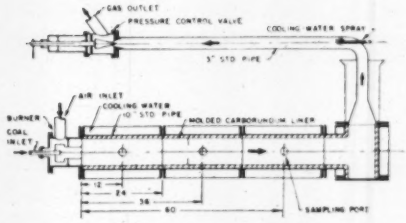
In 1930 the Milwaukee company began the design of a new power plant at Port Washington, Wis. The first unit of 80,000 kw capacity was completed and went into operation in November, 1935. The unit is a single-boiler, single-turbine design, having a 690,000-lb per hr capacity, 1390-psi boiler. A second 80,000-kw unit began operation in 1943. A third 80,000-kw unit will be placed in operation during 1948, and a fourth 80,000-kw unit is on order.

One feature of Milwaukee's designs for burning pulverized coal is the use of dual forced-draft fans, dual induced-draft fans, and dual primary-air fans. Double fans permit a flexible range in loading, greater reliability, and ability to continue to operate at about 60 per cent capacity with a single fan in case the other fan or its drive is out of service for repair. The use of dual auxiliaries has permitted long periods of continuous operation of the units.

Another feature is the use of large water and steam-cooled furnaces to avoid the formation of slag in so far as possible. It is realized that the larger furnace costs more and requires a larger building, but the engineers of the Milwaukee company firmly believe that the additional cost is warranted by freedom from slagging troubles. The maximum rate of heat release is in the neighborhood of 15,000 Btu per cu ft. The use of maximum cooling surfaces, water and steam, and the minimum of refractory obtains the low temperature and freedom from slag troubles.

Experimental Combustion of Pulverized Coal at Atmospheric and Elevated Pressures, by H. R. Hazard, Mem. ASME, Battelle Memorial Institute, Columbus, Ohio, and F. D. Buckley, Mem. ASME, Locomotive Development Committee, Dunkirk, N. Y. 1947 ASME Annual Meeting paper No. 47—A-117 (in type; published in Trans. ASME, August, 1948, pp. 729–737).

Among the basic problems associated with the development of a gas-turbine plant to use pulverized coal are those related to the burning of the pulverized coal under gas-turbine conditions. These conditions include high heat-release rates, high excess air, high static pressures, and a wide range of variation in all operating conditions. No previous data indicating the effects of pressure on the reaction rate of pulverized coal were available at the start of this investigation, and there had been little occasion to burn pulverized coal at the high heat-release rates used in gas-turbine practice when burning liquid fuels. This paper presents results obtained in a study of the effect of pressure upon the combustion reaction, and describes tests made with



SECTIONAL VIEW OF PRESSURE FURNACE

four small air-cooled combustors operated at high heat-release rates and low pressure in connection with a small gas-turbine unit. The work described was sponsored by the Locomotive Development Committee of Bituminous Coal Research, Inc., under J. I. Yellott, director of research. It was one of several projects, related to the development of the coal-burning gas-turbine locomotive, which have been assigned to a number of universities and research institutions, and which have been described by Yellott in a recent paper. At the present time, large-scale development work is under way both at Battelle, where full-scale atmospheric-pressure combustors are under test, and at the Dunkirk, N. Y., plant of the American Locomotive Company, where full-scale coal-preparation equipment is being operated with a 1/3-scale combustor at full pressure.

Properties of Gases

THE following eleven papers, contributed by the Applied Mechanics and Heat Transfer Divisions, under the auspices of the Research Committee on Properties of Gases and Gas Mixtures, and presented at the 1947 ASME Annual Meeting, appears in the August, 1948, issue of Transactions of the ASME. Since these papers are so closely related, they will be available only through purchase of the Transactions at $1 per copy to ASME members and $1.50 per copy to nonmembers. Individual pamphlet copies will not be available.

I—Introductory Comments to a Series of Contributions on Gas Properties, by F. G. Keyes, Massachusetts Institute of Technology, Cambridge, Mass. 1947 ASME Annual Meeting paper No. 47—A-161.

The symposium of which this comment serves as an introduction is the result of a meeting in April, 1947, of the ASME Special Research Committee on Properties of Gases, at which it was decided to review the present available knowledge of the properties of twelve gases and to plan a program of investiga-

tions to amplify this knowledge to meet present-day application requirements. The twelve pure substances are helium, argon, mercury, hydrogen, nitrogen, oxygen, carbon monoxide, water, carbon dioxide, ammonia, methane, and ethylene, to which the natural mixture air has been added because of its general importance.

II—Molecular Constants From Spectroscopic Data, by G. Herzberg, Yerkes Observatory of the University of Chicago, Williams Bay, Wis. 1947 ASME Annual Meeting paper No. 47—A-162.

A brief discussion is given of how from the study of molecular spectra those molecular constants can be obtained that are of importance for the calculation of thermodynamic functions of gases in the ideal gaseous state. Subsequently, the existing data are reviewed for the specific gases at present under consideration by the ASME Special Research Committee on Properties of Gases.

III—Heats of Formation and Chemical Thermodynamic Properties, by Frederick D. Rossini, National Bureau of Standards, Washington, D. C. 1947 ASME Annual Meeting paper No. 47—A-163.

This report describes the tables of selected values of chemical thermodynamic properties issued by the National Bureau of Standards and presents a summary of values of the heats of formation of the molecules H_2O, CO, CO_2, CH_4, C_2H_4, NH_3, and the atoms O, H, N, C, all in the gaseous state.

IV—Vapor Pressure, Specific Volume, p-v-T Data for H_2, N_2, O_2, CO, CO_2, Air, He, A, Hg, by Serge Gratch, Jun. Mem. ASME, University of Pennsylvania, Philadelphia, Pa. 1947 ASME Annual Meeting paper No. 47—A-164.

Accurate p-v-T data are available for the pure gases H_2, N_2, He, and A, from very low temperatures to about 400 C; for O_2 from —152 to 100 C; for CO from —70 to 200 C; from CO_2 from 0 to 150 C; for air from —145 to 200 C. For Hg, p-v-T data are practically nonexistent. With the exception of the systems N_2-H_2 and N_2-CH_4, p-v-T data for mixtures of the gases here considered are quite incomplete and certainly inadequate for accurate practical applications. Adequate vapor-pressure data are available for all the pure gases here considered, but not for their mixtures. The theory of gas properties has been developed sufficiently to be useful for formulation and reasonable extrapolation of existing data; however, present theory is inadequate for reliable a priori calculation of gas properties, except for the simplest molecules.

V—Vapor Pressure, Specific Volumes, and p-v-T Data for H_2O, NH_3, CH_4, C_2H_4 With Comments on Mixtures, by F. G. Keyes, Massachusetts Institute of Technology, Cambridge, Mass. 1947 ASME Annual Meeting paper No. 47—A-165.

Because of its importance wherever thermodynamics is used, reference is made to the need of improved knowledge of the relation of the international scale of 1927 to the thermodynamic scale. The published results of James A. Beattie comprise comparisons between the scales from 32 F to 832.28 F and indicate that the thermodynamic-scale temperature as a maximum is 0.26 F greater than the international scale at about 750 F. The new thermometric information makes possible a thermodynamic consistency test of vaporization data, vapor pressures, and volume data from the steam investigation sponsored by this Society up to 1935. It is suggested that additional volume data are desirable above 860 F. Comments are offered on the known thermodynamic properties of water, ammonia, methane, ethylene, and mixtures of a number of the eleven pure gases of the list selected by the Research Committee on Properties of Gases and Gas Mixtures.

VI—Dielectric-Constant and Refractivity Data, by J. G. Miller, University of Pennsylvania, Philadelphia, Pa. 1947 ASME Annual Meeting paper No. 47—A-166.

The dielectric constant and refractivity data already established at lower pressures for the twelve gases under consideration need little improvement. A few outstanding gaps in these data are specified. Accurate high-pressure data have been published for only a few of the gases, principally hydrogen, nitrogen, carbon dioxide, and ammonia. Even with these four gases, improvement in the techniques of measuring dielectric constants at high pressures is needed so that more accurate and more extensive studies can be made.

VII—A Summary of Experimental Determinations of Joule-Thomson Effects in Gases, by H. L. Johnston and David White, The Ohio State University, Columbus, Ohio. 1947 ASME Annual Meeting paper No. 47—A-167.

A record is given of work on temperature effects which accompany the free expansion of gases from the classic experiments of Joule and Thomson in 1852–1862, down to present time. For purposes of summarizing present knowledge of Joule-Thomson data, more detailed information, which has been published since 1920, is included. Reliable methods are now available for the derivation of data of this character, which are of practical value in the thermodynamic treatment of gases under pressure. These are described briefly.

VIII—Brief Review of Available Data on the Dynamic Viscosity and Thermal Conductivity for Twelve Gases, by G. A. Hawkins, Mem. ASME, Purdue University, Lafayette, Ind. 1947 ASME Annual Meeting paper No. 47—A-168.

A brief review of the available data relative to the dynamic viscosity and thermal conductivity for twelve gases is presented in order to show the need for future experimental work. The values found in the survey for the thermal conductivity and viscosity for the various gases at a pressure of approximately 1 atm have been analyzed and average values presented in the form of graphs to show the influence of the temperature.

Industry's Requirements for Data on Gas Properties, by N. A. Hall, University of Minnesota, Minneapolis, Minn. 1947 ASME Annual Meeting paper No. 47—A-169.

A broad survey has been made among industries for which data upon the properties of the gases treated in this series of papers are of great importance. The requirements specified, which are being submitted to the ASME Special Research Committee, will be of great aid in formulating the research program. Full cooperation in the work to be undertaken will be supplied by industry and Federal agencies.

Facilities for, and Work Under Way in Gas-Properties Research, by R. V. Kleinschmidt, Mem. ASME. 1947 ASME Annual Meeting paper No. 47—A-170.

The Subcommittee on Research Planning of the Research Committee on Properties of Gases has made a survey of laboratories believed to be interested in research on gas properties, to determine (1) work completed, (2) work in progress, (3) facilities and experienced personnel available but not now utilized, and (4) other laboratories that might be interested in developing such equipment and personnel.

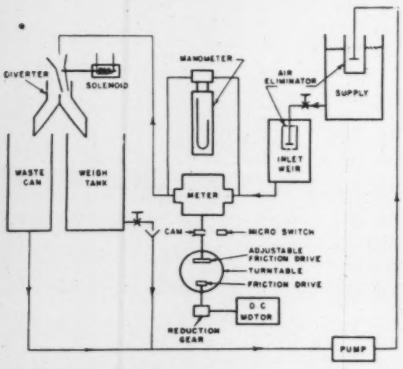
Generalized Thermodynamics of High-Temperature Combustion, by H. C. Hottel, Mem. ASME, G. C. Williams, and C. N. Satterfield, Massachusetts Institute of Technology, Cambridge, Mass. 1947 ASME Annual Meeting paper No. **47—A-121.**

The ability to calculate the performance of any proposed type of heating operation or power-plant combustion cycle requires a knowledge of the thermodynamic properties of the system. If the systems encountered consist of any combination of the four species, carbon-hydrogen-oxygen-nitrogen, in any reasonable proportion, the number of thermodynamic charts necessary for a solution with minimum interpolation would be enormous without specially developed procedures. This paper presents a method of expressing the thermodyanmic properties of the four-component system in a dimensionless form which permits putting the whole system onto a simple set of charts for easy engineering use. The present data have particular value in calculating flame temperatures and in solving the performance of liquid-fuel rocket power plants. The data span the range of operation of conventional combustion systems and therefore also apply to systems such as furnaces operated with oxygen enrichment or very high preheat, as well as most usual power cycles. The method of use is illustrated by application to a rocket system.

Fluid Meters

Analysis of Tests on Positive-Displacement Meters for Liquid Hydrocarbons, by E. E. Ambrosius, Mem. ASME, The Pennsylvania State College, State College, Pa. 1947 ASME Annual Meeting paper No. **47—A-171** (in type; published in Trans. ASME, August, 1948, pp. 703–708).

This paper gives an amplification of results of tests on one meter and represents a method of analysis of data from the tests conducted by the ASME Special Research Committee on Fluid Meters and the API Topical Committee on Volumeter Research, to determine the characteristics of displacement-type mechanical meters when measuring liquid hydrocarbons. It is a continuation of an earlier paper, ("Results of Tests on Volumeters for Liquid Hydrocarbons," by R. J. S. Pigott, E. E. Ambrosius, and E. W. Jacobson, Trans. ASME, vol. 65, 1943, pp. 350–352) and presents data with a method of further analysis beyond that made in the preliminary study. The early paper discussed the results in a general way. A more thorough study of the data on a particular meter, such as herein presented, can point the way toward close control of meter performance characteristics for any particular design.



SCHEMATIC DIAGRAM OF TEST SETUP FOR DETERMINING DISPLACEMENT OF METERS

Steam Contamination

High-Pressure Turbine Deposit Experience, by W. L. Webb, American Gas and Electric Service Corporation, New York, N. Y. 1948 ASME Semi-Annual Meeting paper No. **48—SA-6** (mimeographed).

Deposit experience in turbines receiving steam from boilers of 1200 psi and above is described. Both soluble and insoluble deposits occur. The plan followed for charting changes in the extent of deposits is indicated. Improvements in caustic-washing technique are suggested and procedures employed for removing soluble deposits are described. Cases are cited where during operation under subnormal load and steam temperature, deposits appear to be transferred from one stage group to another.

Customary procedure for detecting the presence of deposits in a turbine consists of periodically measuring shell stage pressures at bleed points and, where pressure taps have been provided, establishing bleed flows from measured steam and condensate flows and from performance of heaters, and computing stage group differential pressures under known stage group steam flows. These differential pressures are then corrected to correspond to adopted standards for throttle steam conditions and for stage group flows comparable to those obtaining under rated load conditions. The corrected differentials are then charted so that trends in changes of turbine cleanliness can be observed and compared with the "clean condition" and "maximum allowable" differentials, as designated for the respective stage groups by the turbine manufacturer.

Deposits adversely affect the turbine efficiency by virtue of disturbing the steam-velocity relations. Deposits may so reduce the cross-sectional area of the steam passages that the normal maximum steam flow will be attained only with excessive differential pressures across the affected stages. This in turn makes necessary the limitation of steam flow, and consequently the output capacity of the turbine.

The most effective means thus far employed on the American Gas and Electric System to reduce deposition has been to maintain the lowest feasible SiO_2 values in the boiler waters, by blowdown control, by holding condenser leakage to a minimum, by obtaining the best possible evaporator vapor purity, and, in general, by excluding contaminants from the cycles to the maximum degree. Various boiler-water constituent ratios and treatments have had little effect in reducing turbine deposits.

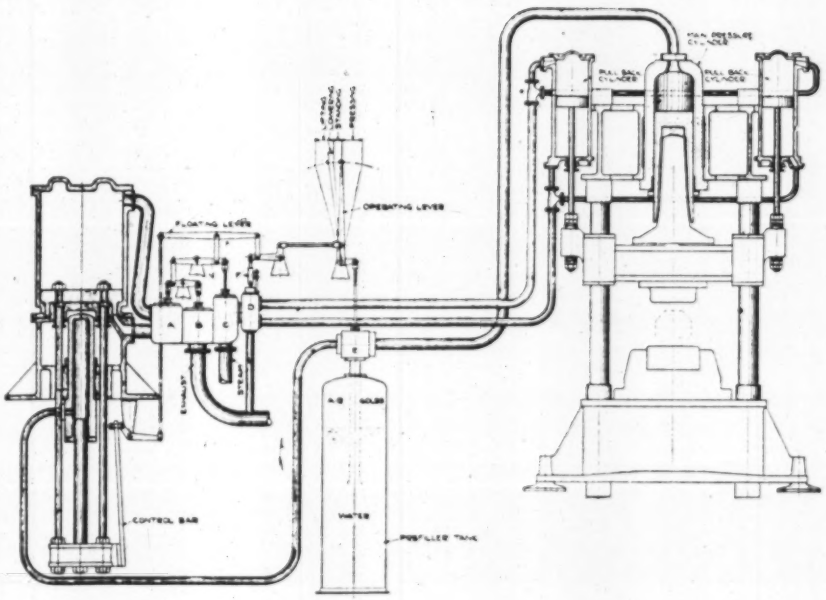
Hydraulics

Laboratory Investigations of the Mechanism of Cavitation, by R. T. Knapp, Mem. ASME, and A. Hollander, Mem. ASME, California Institute of Technology, Pasadena, Calif. 1947 Annual Meeting paper No. **47—A-150** (in type; published in Trans. ASME, July, 1948, pp. 419–435).

The paper describes some experimental investigations of the formation and collapse of cavitation bubbles. The experiments were carried on in the high-speed water tunnel of the Hydrodynamics Laboratory of the California Institute of Technology under the sponsorship of the Research and Development Division of the Bureau of Ordnance of the U. S. Navy and the Fluid Mechanics Section of the Office of Naval Research. A detailed study of the formation and collapse of the individual bubbles has been carried on by the use of high-speed motion pictures taken at rates up to 20,000 per sec. From these records calculations have been made of rate of formation and collapse of the bubbles. Deductions have been drawn from these results concerning the physical mechanism of the cavitation phenomenon.

Large Hydraulic Forging Presses, by M. D. Stone, Mem. ASME, United Engineering and Foundry Company, Pittsburgh, Pa. 1947 ASME Annual Meeting paper No. **47—A-151** (in type; published in Trans. ASME, July, 1948, pp. 499–514).

An historical account of the art of forging is given, which traces the development of the machines used, culminating in the 14,000-ton forging presses built for the U. S. Navy during the recent war. Two forging presses of this size were built



DAVY-UNITED STEAM-HYDRAULIC PRESS AND CONTROL GEAR

and installed at the Naval Ordnance Division, Midvale Steel Company, Philadelphia, Pa., and at the Naval Ordnance Plant, South Charleston, W. Va., respectively. In one case an electric-drive pump system working in conjunction with a hydropneumatic accumulator is used as the power plant, while the other is of the steam-hydraulic type. A detailed account of the design, construction, installation, and operation of each press is given as well as comparative performance data, cost studies, and the like.

Numerous other installations of heavy stamping or die-forging presses of various types and capacities up to 30,000 metric tons at the I. G. Farben Company in Germany are described at some length.

Applied Mechanics

Tensorial Analysis of Control Systems, by Gabirel Kron, General Electric Company, Schenectady, N. Y. 1947 ASME Annual Meeting paper No. 47—A-152 (in type; published in the *Journal of Applied Mechanics*, June, 1948, pp. 107–124).

The equations of small oscillations superimposed upon a state of steady motion may usually be represented by a set of linear algebraic equations $Z_{\alpha\beta}\Delta x^{\beta} = \Delta f_{\alpha}$. When a complex dynamical system is given, such as a servomechanism, it is possible to establish the resultant equations by first removing all interconnections between the various amplification stages and finding the impedance matrix $Z_{\alpha\beta}$ of each isolated stage. The effect of their interconnection is representable by a matrix of transformation $C^{\alpha}{}_{\alpha'}$. The impedance matrix $Z_{\alpha'\beta'}$ of the resultant system may be found without any physical analysis by a simple routine matrix manipulation involving $Z_{\alpha\beta}$, $C^{\alpha}{}_{\alpha'}$, its partial derivatives $\partial C^{\alpha}{}_{\alpha'}/\partial x^{\alpha}$ and the steady-state force vector f_{α}. (In oscillatory problems the law of transformation of the impedance matrix $Z_{\alpha\beta}$ is not that of a tensor.) The method is illustrated by setting up the differential equations of various types of speed, pressure, and position-governing systems used in central-station work.

ASME Transactions for September, 1948

THE September, 1948, issue of the Transactions of the ASME, which is the *Journal of Applied Mechanics*, contains the Symposium on Flow and Fracture of Metals, jointly sponsored by the ASME Applied Mechanics Division and the ASME Special Research Committee on Plastic Flow of Metals and presented at the 1948 ASME Applied Mechanics Division Meeting.

Flow and Fracture of Steel Under Combined Stress

Experimental Studies of Biaxially Stressed Mild Steel in the Plastic Range, by S. J. Fraenkel (Paper No. 48—APM-1)

Behavior of Steel Under Biaxial Stress as Determined by Tests on Tubes, by H. E. Davis and E. R. Parker (Paper No. 48—APM-20)

The Effect of Size and Stored Energy on the Fracture of Tubular Specimens, by E. A. Davis (Paper No. 48—APM-12)

Theory of Plasticity

Some Properties of a Mechanical Model of Plasticity, by H. F. Bohnenblust and Pol Duwez (Paper No. 48—APM-10)

The Stress-Strain Laws of the Mathematical Theory of Plasticity—a Survey of Recent Progress, by William Prager (Paper No. 48—APM-14)

Stress-Strain Relations for Finite Elastoplastic Deformations, by J. E. Dorn and A. J. Latter (Paper No. 48—APM-15)

A Generalized Deformation Law, by E. A. Davis (Paper No. 48—APM-13)

The General Proof of the Principle of Maximum Plastic Resistance, by A. H. Philippidis (Paper No. 48—APM-2)

Impulsive Loading in the Plastic Range

Propagation of Discontinuities and Plastic Waves

Discussion of the Forces Acting in Tension Impact Tests of Materials, by D. S. Clark and P. E. Duwez (Paper No. 48—APM-18)

A Method of Making High-Speed Compression Tests on Small Copper Cylinders, by E. T. Habib (Paper No. 48—APM-9)

The Propagation of Plasticity in Uniaxial Compression, by M. P. White and LeVan Griffis (Paper No. 48—APM-17)

The Interaction of Discontinuity Surfaces in Plastic Fields of Stress, by Alice Winzer and G. F. Carrier (Paper No. 48—APM-16)

Plastic Flow and Fracture

A Law of Work-Hardening, by A. M. Freudenthal and M. Reiner (Paper No. 48—APM-6)

The Influence of the Dimensional Factors on the Mode of Yielding and Fracture in Medium-Carbon Steel—I, by Julius Miklowitz (Paper No. 48—APM-19)

Plastic Deformation of a Circular Diaphragm Under Pressure, by A. Gleyzal (Paper No. 48—APM-11)

Contact Stresses in the Rolling of Metals—I, by C. W. MacGregor and R. B. Palme (Paper No. 48—APM-22)

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Failure of Metals by Fatigue

THE FAILURE OF METALS BY FATIGUE. Proceedings of a symposium held at the University of Melbourne, December 2–6, 1946, with a foreword by H. J. Gough. 505 pp., 89 illus. Melbourne University Press.

REVIEWED BY A. NADAI[1]

THE well-known British authority on the fatigue of metals, Dr. H. J. Gough, writes in the foreword of this book that "the University of Melbourne has rendered a signal service to a wide circle of scientists and engineers throughout the world," by publishing this comprehensive discussion on the broad subject of the fatigue of metals. This book of 505 pages, wholly printed in Australia contains a collection of 30 shorter papers which were presented during a three-day symposium held at the University of Melbourne through the initiative of a convening committee, chairman of which was the well-known professor of metallurgy of this university, Dr. J. Neill Greenwood, also known for his outstanding work on the creep of lead. Further members of the committee were Dr. W. Boas; Messrs. Shaw, E. G. Thurlby, and H. A. Wills. Among the papers a number were invited papers received from England and from the United States by such authors as Prof. H. F. Moore, Mem. ASME, University of Illinois, George Sachs, Mem. ASME, and others. In his opening remarks, Professor Greenwood said that he hoped one result of this symposium would be to bring a spirit of co-operation between engineers and metallurgists.

From its table of content a few subjects may be quoted as follows: "Theories of the Mechanism of Fatigue Failure," by W. Boas; "The Electrochemistry of Corrosion Fatigue," by U. R. Evans; "The Detection of Fatigue Cracks," by C. W. Orr; "The Measurement of Dynamic Strain," by F. W. Hooton; "Determination of Stress Concentration Factors," by F. S. Shaw; "Photo-Elasticity and Stress Concentration," by W. H. H. Gibson; "The Design of Cylindrical Shafts Subjected to Fluctuating Loading," by G. G. McDonald; "The Influence of Radial Pressure from a Press Fit on the Endurance Limit of Axles and crank pins," by G. W. C. Hirst; "Fatique Failure of Axles of Car and Wagon Railway Rolling Stock," by E. Connor, and others.

Most of the 30 independent contributions published in this volume are comparatively short popularly written articles on the general subject of the failure of metals by fatigue. Each lecture is followed by a record of the ensuing discussion. Many illustrations of curves, micrographs, and photographic reproductions of fatigue failures are contained in this book. It is an up-to-date review of the progress in general engineering mechanics in this specific important field. Although no significant additions appear to have been contributed during these war and afterwar years to the understanding of the basic problems of the fatigue failures of metals, the volume may convey the up-to-date information on the various researches which were carried out in many countries. The engineers in this country will welcome this recent addition to the descriptive literature on the subject of fatigue of metals.

[1] Consulting Mechanical Engineer, Westinghouse Research Laboratories, East Pittsburgh, Pa. Mem. ASME.

Scale Models in Hydraulic Engineering

SCALE MODELS IN HYDRAULIC ENGINEERING. By J. Allen. Longmans, Green and Company, New York, N. Y., 1947. Cloth $5\frac{1}{2} \times 8\frac{1}{2}$ in., 407 pp., 137 fig., illus., $7.25.

REVIEWED BY O. E. TEICHMANN[2]

DURING the last few decades the importance of model studies in the field of fluid flow has increased tremendously. Wing sections and airplane designs are being studied on scale models in the wind tunnel and the ship designer tests ship models in the towing basin. The mechanical engineer predicts the efficiency of new designs of turbines and pumps from tests on scale models. The structural engineer tests models of bridges and buildings to obtain information about the behavior of the full-scale structures under wind load, and the civil engineer works with models of hydraulic structures and rivers to obtain more reliable solutions to his design problems.

The book under review is written from the point of view of the civil engineer and is primarily concerned with model studies on hydraulic structures and rivers. There was definitely a great need for a book of this kind. Since the publication of John R. Freeman's "Hydraulic Laboratory Practice" published by The American Society of Mechanical Engineers in 1929, a great amount of work has been carried out and numerous papers were written on the subject. There was not only a need for collecting this material for easy reference, but the time was ripe "to set down the principles which underlie the technique of many kinds of hydraulic model experiments..., and to provide a critical survey of the present situation, drawing attention to the limitations as well as the advantages of the method." The author who states this as his purpose in writing the book has solved his self-imposed task in a very successful manner.

The introductory chapter of the book presents the fundamental consideration in model technique. Dimensional analysis is introduced to the reader by giving the historical development of its most prominent example, the flow in pipes, rather than by developing it from a mathematical point of view by way of Buckingham's Pi theorem. This is followed by discussions of the similarity of straight open channels, of the "scale effect" in the case of tortuous channels, and of separation of viscosity and inertia effects; only then is given a more general treatment of dimensional analysis with complete demonstrations of how to use it on pertinent examples such as weirs and orifices, screw propellers, hydraulic pumps and turbines, surge-tank installations, and problems involving heat transfer.

The next two chapters go into the details of model experiments on weirs, spillways, sluice gates, and bridge piers. Here, and throughout the rest of the

[2] Supervisor Fluid Mechanics, Armour Research Foundation, Chicago, Ill., Member ASME.

book, the author draws partly from available material, but to a greater degree, he describes work carried out in England, in particular at the University of Manchester under Prof. A. H. Gibson and the author, himself. Descriptions of models of nontidal rivers and of tidal rivers follow. The dimensional analysis responsible for the scale of the model and the choice of the bed material in the model are discussed in detail, comparisons with measurements in the rivers are pointed out, and the importance of the scale effect is brought out again.

Under "Salt and Salinity" is discussed the problem of what concentration a saline solution of water should be when used in the model to simulate the falling rate of silt in salt water, considering the different horizontal and vertical scales on the model. Then follows a thirty-page discussion of four tidal model investigations carried out in England during the last fifteen years, and special attention is drawn to features contributing to the general technique of such investigations. These model investigations are on the Mersey, Rangoon, Dee, and Parrett Rivers, and experiments have been employed, with practically every known method of improving drainage and navigability and of reducing the amount of dredging required. Conclusions are drawn from the experience gained during these tests as to the most reasonable choice of scale for a tidal model, taking such important factors into account as available water supply, quantities of silt needed for a daily operation, and the influence of the vertical distortion upon settling speed and the angle of repose of the sand.

Tide-generating mechanisms are reviewed and recent investigations of the author are abstracted on the stability of bed materials in a stream of water, taking into account blocks, broken stone, and sand. An account is given of the laboratory study of wave phenomena, of measuring devices, and of the construction of river models in general. At the end of the book thirty-five photographs supplement the text, showing models, laboratory installations, and views of actual river installations.

The hydraulic engineer will be pleased to find in this book the condensations of years of experience in the field of river model testing. The practicing engineer, in general, and the research worker will receive valuable stimulation to use the method of model testing for solving problems and for checking solutions in his particular field of interest and activity.

The Dynamics of Automatic Controls

The Dynamics of Automatic Controls. By R. C. Oldenbourg and H. Sartorius. Translated and edited by H. L. Mason. Published by the ASME, New York, N. Y., 1948. Cloth, 6 × 9 in., 275 pp., 126 illus., $7.50.

Reviewed by George A. Philbrick[3]

THE orginal German work, *Dynamik Selbsttatiger Regelungen*, of which the book under review is an English-language version, has already been ably reviewed by the translator.[4] Publication of this new edition was sponsored by the Industrial Instruments and Regulators Division of The American Society of Mechanical Engineers, forming thus a very substantial contribution to the usable literature of the subject.

The translated text is reproduced from typewritten pages, yet is quite legible. Wherever possible, direct facsimiles of the original figures and mathematics are incorporated with a minimum of alteration to bring wording and symbols acceptably into line. There have been added 19 references which were not included in the bibliography of the original edition.

In view of the prior review, no attempt is here made to restate exhaustively the subject matter which is encompassed. A few additional remarks are considered to be in order, however, applying uniformly to the German book and to its translation. Aside from the remarkably concise and orderly presentation, and the high mathematical caliber of this book, it is most noteworthy for its attention to nonlinear phenomena and for its application of an unusual criterion for effectiveness of control. This criterion relates control effectiveness to the time integral of the difference between the regulated variable and its new equilibrium value, during an aperiodic transient recovery. To this reviewer such a criterion is preferable to the minimization of root-mean-square variation. It appears to require extension, however, to cover those important aperiodic cases which involve a (usually small) finite number of "oscillations" about equilibrium following a discrete disturbance.

For a plant with dead time, and comparing the actions of continuous and intermittent controls under certain restricted conditions, the authors show the latter to be more "effective" in the sense of the foregoing criterion. It is to be hoped that hasty and erroneous generalizations will not be built upon this remarkable but certainly limited instance.

As to the translation, Professor Mason's knowledge and experience in automatic controls have contributed heavily to its success. His choice of words shows unusual appreciation and articulateness, although some engineers may find a few of his terms a bit special. Thanks are due to all responsible for a fine job.

[3] President, George A. Philbrick Researches, Inc., Boston, Mass. Jun. ASME.

[4] Mechanical Engineering, vol. 68, May, 1946, p. 474.

Studies in Heat Conduction

Heat Conduction With Engineering and Geological Application. By Leonard R. Ingersoll, Otto J. Zobel, and Alfred C. Ingersoll. McGraw-Hill Book Company, Inc., New York, N. Y., 1948. 6¼ × 9¼ in., 278 pp., $4.

Reviewed by E. B. Penrod[5]

ENGINEERS, physicists, and geologists should welcome this book which has been written by authorities in the field of heat conduction. L. R. Ingersoll is professor of physics at the University of Wisconsin; O. J. Zobel is a member of the technical staff of the Bell Telephone Laboratories; and A. C. Ingersoll is instructor in civil engineering at the University of Wisconsin.

This book is a successor to a similar book published formerly by Ingersoll and Zobel. The authors developed the subject of heat conduction with special reference to the needs of superior students of engineering, physics, and geology who have completed a formal course in differential and integral calculus. The mathematical theory is supplemented with a wide variety of applications to furnace walls, insulating refrigerators and airplane cabins, temperature drop through boiler shells, heat loss through insulated steam pipes, gas-turbine cooling, electric welding, hardening of steel, shrink fittings, vulcanizing, heat sources for the heat pump, thawing of frozen soil, cooling of lava, cooling of concrete dams, and the formation of ice.

After the theory of periodic flow of heat in one dimension is developed, the authors give an excellent introduction to Fourier series and to the Fourier integral. In a subsequent chapter the authors assumed that the reader was familiar with Bessel's equation, its solution, and refers

[5] Head, Department of Mechanical Engineering, College of Engineering, University of Kentucky, Lexington, Ky.

him to advanced books for the properties of Bessel functions. The value of the book would be enhanced a great deal if the authors had chosen a practical problem in heat conduction to introduce Bessel's equation and given a general solution of it. At this point the beginner would have enjoyed reading the particular solutions to several practical problems in order to become familiar with the use of the table on Bessel functions which is included in the book.

A large number of excellent problems, with answers, are given so that the reader can have an opportunity to apply the theory. Teachers, students, and engineers will find this book an excellent reference in the field of heat transfer. The McGraw-Hill Book Company is to be congratulated on adding such a timely book to its International Series in Pure and Applied Physics.

Electric Traction for Cranes

ELECTRIC TRACTION FOR CRANES. By Richard A. West. Pitman Publishing Corp. New York, N. Y., 1946. Cloth, $5^3/_8 \times 8^1/_2$ in., 86 pp., illus. $3.50.

REVIEWED BY V. J. KROPF[6]

MR. West has made a very valuable and comprehensive study of the problems involved in the application of electrical equipment for crane drives. Although principally devoted to bridge and travel motions, Mr. West's analysis includes hoist motions and compares inertia requirements of typical hoist and travel motors.

This is a fundamental treatment of the principles involved in motor selection, for all crane motions. Consideration is given to both alternating-current and direct-current apparatus.

All of the various factors concerned in determining power requirements, such as loading, friction, speed, and acceleration problems, are well presented. Details of motor design, speed, and torque, as well as associated control, resistance, and contactors, are brought out quite clearly.

The author makes use of numerous sample calculations, graphic representations, and other technical data which places this book on a par with the larger textbooks and can well be considered as such. While it is written in sufficient detail so that a beginner can learn the subject easily, it represents advanced thinking which can serve as an authoritative guide to experienced application engineers.

[6] Application Engineer in Charge of Materials Handling. Westinghouse Electric Corporation, East Pittsburgh, Pa. Mem. ASME.

Books Received in Library

AMERICAN SOCIETY FOR TESTING MATERIALS, PROCEEDINGS, vol. 47, 1947, Committee Reports, Technical Papers. American Society for Testing Materials, Philadelphia, Pa.. 1948. Cloth, $6 \times 9^1/_4$ in., 1197 pp., illus., diagrams, charts, tables, $12. The two major parts of this volume are (1) the reports and recommendations of the technical committees of the Society, and (2) the technical papers presented at the Society meetings, grouped under several broad classifications. The articles appearing in the ASTM Bulletin are listed by titles, and brief summaries are given of the several symposiums on the following subjects: insulating oil; synthetic lubricants; rubber testing; bearing capacity of soils; effect of low temperatures on materials; paint and paint materials.

BRITISH DIESEL ENGINE CATALOGUE published for the British Internal Combustion Engine Manufacturers' Association, London, England, by Temple Press Limited, London, England, 1947. Cloth, $9^3/_4 \times 13^1/_4$ in., 247 pp., illus., diagrams, charts, tables, 42s. Of interest to the buyer of Diesel engines, this catalogue gives particulars of over 1800 British-made engines. An unusually comprehensive index simplifies the task of discovering the actual model which meets specific requirements in the matter of class of service, design principles, power, and speed. Tables, providing all vital statistics, are in appropriate sections, so that quick and accurate comparisons can be made.

COPPER AS AN ALLOYING ELEMENT IN STEEL AND CAST IRON. By C. H. Lorig and R. R. Adams. McGraw-Hill Book Co., Inc., New York, N. Y., Toronto, Canada, London, England, 1948. Cloth, $6 \times 9^1/_4$ in., 213 pp., illus., charts, tables, $3. This book makes readily available the pertinent information on ferrous materials containing small amounts of copper. Recent advances in the metallurgy of copper-bearing iron and steel are considered. Practical data on the properties, characteristics, and applications of cast and wrought copper steels, copper cast iron, and copper malleable iron are included.

COURS DE MÉCANIQUE, vol. 2, DYNAMIQUE DES CORPS SOLIDES RIGIDES. By H. Favre. Dunod, Éditeur, Paris, France; Leemann Freres, Éditeurs, Zurich, Switzerland, 1947. Paper, $6^1/_4 \times 9^1/_4$ in., 434 pp., diagrams, tables, 1380 fr. Written for engineers, physicists, and mathematicians who wish to acquire an overall view of classical mechanics, this book not only presents the theory, but gives the formulas in a direct method applicable to concrete cases. This second volume covers the dynamics of points, rigid bodies, and systems with a full analytical treatment. Problems for student solution follow each chapter. Volume 1 of the series covered statics, and volume 3 will deal with the theory of elasticity, elastic bodies, and hydrodynamics.

DESIGN OF METAL CUTTING TOOLS. By F. L. Woodcock. McGraw-Hill Book Inc. Co., New York, N. Y., Toronto, Canada, London, England, 1948. Cloth, $6 \times 9^1/_4$ in., 406 pp., illus., diagrams, tables, $5. Based on actual shop experience, this book is of interest to tool designers, draftsmen, and shop foremen. It provides rules, formulas, and tabular information to aid in the most profitable and efficient design of all metal-cutting tools. Applying each tool to its job, it also gives salvage data for worn-out tools by showing how to adapt them to new uses. Fundamentals of design and practical procedures are presented.

EFFICIENT USE OF STEAM, written for the Fuel Efficiency Committee of the Ministry of Fuel and Power. By O. Lyle. His Majesty's Stationery Office, London, England, 1947. Cloth, 6×10 in., 912 pp., diagrams, charts, tables, 15s. This comprehensive work, a companion volume to the previously published "Efficient Use of Fuel", discusses the design, operation, control, and maintenance of equipment for the use of heating, power, and process steam. The necessary minimum of theory is given, accessories are covered in detail, necessary tables and formulas are appended for quick reference, and a detailed index is provided. The book is designed not only for the steam specialist but also for the factory manager and any other nontechnically trained persons who are concerned with steam.

ELECTRIC POWER STATIONS, vol. I. By T. H. Carr, with a foreword by Sir L. Pearce. Third edition. revised and enlarged. Chapman & Hall, Ltd., London, England, 1947. Cloth, $5^1/_2 \times 8^3/_4$ in., 513 pp., illus., diagrams, charts, tables, 36s. The opening chapters deal briefly with the fundamentals of station design and construction. Succeeding chapters give detailed information on the following major topics: circulating water systems; cooling towers; coal-handling plant; ash-handling plant; pipework; turbines; and a large section covering the boiler plant. A bibliography accompanies each chapter.

FAN ENGINEERING, an Engineer's Handbook, edited by R. D. Madison. Fifth edition. Buffalo Forge Company, Buffalo, N. Y., 1948. Cloth, $4^1/_2 \times 7$ in., 808 pp., illus., diagrams, charts, tables, $6. The four major parts of this useful manual deal respectively with: the physics of air; fan characteristics, dynamics, testing; fan applications; fans and air-conditioning equipment. Theoretical principles and descriptive material have been condensed in order to include as much engineering data as possible. The book has been revised throughout to conform to current practice and a more complete ready reference index to charts and tables is provided.

FORMING OF AUSTENITIC CHROMIUM-NICKEL STAINLESS STEELS, assembled and edited by V. N. Krivobok and G. Sachs. International Nickel Co., New York, N. Y., 1948. Cloth, $8^1/_2 \times 11^1/_4$ in., 309 pp., illus., diagrams, charts, tables, $4. This book gives fabricators of metal equipment a better understanding of the adaptability of stainless steels to all modern processes of forming. It presents a detailed description of the modern forming procedures as applied to chromium-nickel stainless steels and as practiced in U. S. plants. Bending and straight flanging; forming of curved sections and tubing; deep drawing; die forming; forming of contour flanged parts; and forming by miscellaneous methods are discussed. The specific examples of forming

technique are supplemented by details of tool design and tool materials, lubricants, data on dimensions, and consecutive steps on fabrication.

HEAT CONDUCTION WITH ENGINEERING AND GEOLOGICAL APPLICATIONS. By L. R. Ingersoll, O. J. Zobel, and A. C. Ingersoll. McGraw-Hill Book Company, Inc., New York, N. Y., Toronto, Canada, and London, England, 1948. Cloth, 6 × 9¼ in., 278 pp., diagrams, charts, tables, $4. Based on the earlier text, "Theory of Heat Conduction", the present volume retains much of the old material, thoroughly revised, and provides new data. It contains many practical applications for the geologist and engineer, including such subjects as ground heat-pump sources, geysers, periodic flow, electric welding, and canning and drying operations. An outstanding feature is the chapter on graphical and other methods by which a large variety of heat-conduction problems may be solved with only the simplest mathematics.

INDEX TO ASTM STANDARDS, December, 1947. American Society for Testing Materials, Philadelphia, Pa. Paper, 5¾ × 8½ in., 248 pp., free upon request. This index provides a ready reference for locating any of the some 1500 standards and tests issued by the ASTM. It also serves those who wish to determine whether ASTM has issued standard specifications, test methods, or definitions covering a particular engineering material or subject.

MANAGEMENT PROCEDURES IN THE DETERMINATION OF INDUSTRIAL RELATIONS POLICIES. By H. Baker. Princeton University, Industrial Relations Section, Research Report Series No. 76, 1948. Paper, 6 × 9¼ in., 81 pp., tables, $2. This report considers the allocation of responsibility for final decisions on major personnel policies, as well as the procedures followed on their formation. Information was gathered from 84 companies with considerable experience in handling industrial-relations problems. Including only companies engaged primarily in manufacturing, consideration is given to the representative nature of the group in respect to size and industry.

MECHANICS OF MACHINERY. By C. W. Ham and E. J. Crane. Third edition. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada, London, England, 1948. Cloth, 6 × 9¼ in., 538 pp., diagrams, tables, $5. This text dealing with the mechanics, kinematics, and dynamics of machinery has been revised and brought up to date. Among the principal additions are chapters on the gyroscope and on vibrations and critical speeds in shafts. Other changes include material on cams and gears, flywheels and governors, and on balancing, with particular reference to airplane engines. The selection of drafting-room problems was made with the view of illustrating practical applications of fundamental theory.

METHODS-TIME MEASUREMENT. By H. B. Maynard, G. J. Stegemerten, and J. L. Schwab. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada; London, England, 1948. Cloth, 6 × 9¼ in., 292 in., illus., diagrams, charts, tables, $3.75. In practical language, this manual shows how to develop production standards without the use of the stop watch, both in the shop and office. It describes the procedure involved in determining the motions required to perform an operation and it shows how to assign predetermined time standards to each limiting motion. Valuable in methods improvement, it enables the methods engineer to handle many types of engineering work with greater facility than ever before.

MODERN METALLURGY OF ALLOYS. By R. H. Harrington. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, Ltd., London, England, 1948. Cloth, 5½ × 8½ in., 209 pp., illus., diagrams, charts, tables, $8.50. Of interest to all research and "works" laboratories and to metallurgists generally, this book emphasizes the "whys" of alloy properties. It correlates modern theory with practical data, including the fundamentals of a new field of alloy treatments. Simple standard definition of heat-treatments, equilibrium diagrams, solid-state reactions, the physics and chemistry of alloys, and porosity are among the topics considered.

MODERN OPERATIONAL CALCULUS WITH APPLICATIONS IN TECHNICAL MATHEMATICS. By N. W. McLachlan. The Macmillan Co., New York, N. Y., and London, England, 1948. Cloth, 5½ × 8½ in., 218 pp., diagrams, tables, $5. Written for postgraduate engineers and technologists, this book is an introduction to operational calculus based on the Laplace transform. Various theorems are used to solve ordinary and partial linear differential equations, to evaluate difficult integrals, to obtain mathematical relationships and expansions, and to derive the Laplace transform of various functions. A modern treatment is given of periodic impulses of finite and infinitesimal duration, based upon complex integration. The examples included are an integral part of the text, for they contain important formulas and additional theorems.

MOLESWORTH'S AERONAUTICAL ENGINEERS POCKET-BOOK. Edited by A. P. Thurston and R. H. Warring. Second edition. E. & F. N. Spon, Ltd., London, England, 1947. Cloth, 4 × 6¼ in., 532 pp., diagrams, charts, tables, 30s, plus 6 d postage. Design data and procedures for airplane structures and power plants are given in detail, including a comprehensive coverage of the strength of important materials. Sections are also devoted to aerodynamic theory, drawing-office procedure, necessary mathematics, instruments, and accessories. Applicable British specifications are listed and an appendix contains data relating to the Royal Aeronautical Society's stressed-skin diagrams. The more than 500 pages of condensed information are contained in a small handy-sized volume.

POWER AND PROCESS STEAM ENGINEERING. By D. Copp. Longmans, Green and Co., New York, N. Y.; Edward Arnold & Co., London, England, 1947. Cloth, 5½ × 8¾ in., 173 pp., illus., diagrams, charts, tables, $3.75. Of value to those interested in the efficient use of industrial fuel, this practical book presents the methods and principles of combined heat and power-producing installations. It emphasizes the fullest use of the latent heat of steam and describes systems which derive the most energy from fuel. Many charts and diagrams illustrate the text.

POWER FROM THE WIND. By P. C. Putnam. D. Van Nostrand Company, Toronto, Canada; New York, N. Y.; and London, England, 1948. Cloth, 6 × 9½ in., 224 pp., illus., diagrams, charts, maps, tables, $6. Of interest to those investigating new sources of power, this is the record of the wind-turbine experiment conducted in Vermont by a group of eminent scientists and engineers. The purpose of the work was to find out the possibilities of generating electricity on a large scale by harnessing the wind. The book summarizes the various technical problems encountered, the attempts at solving them, and the findings and discoveries made.

PRINCIPLES OF PERSONNEL TESTING. By C. H. Lawshe, Jr. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada; London, England, 1948. Cloth, 6 × 9¼ in., 225 pp., diagrams, charts, tables, $3.50. Here is a practical treatment of the accepted procedure for selecting, validating, and using personnel tests in business and industrial situations. Comprehensive in scope but simple in presentation, the book covers the various types of tests and cites pertinent examples from the literature to indicate those kinds of situations in which specific kinds of tests have been useful. Emphasis is placed upon procedure and results rather than theory. Advantages and limitations are clearly shown.

PRINCIPLES OF SERVOMECHANISMS, Dynamics and Synthesis of Closed-Loop Control Systems. By G. S. Brown and D. P. Campbell. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, Ltd., London, England; 1948. Cloth, 5¾ × 9¼ in., 400 pp., illus., diagrams, charts, tables, $5. Of interest to the scientist, practicing engineer, teacher and student, this book offers a comprehensive treatment of closed-loop dynamics and synthesis. It describes the principles of the closed-loop automatic control, stressing actual system design, and offers a direct approach to system synthesis by interrelating the transient and frequency behavior. Techniques for laboratory studies are given as well as problems for student exercise.

REFRESHER NOTES, HYDRAULICS, THERMODYNAMICS, MACHINE DESIGN, for Professional Engineers License Examination. By J. D. Constance, author and publisher, 506 Olympia Ave., Cliffside Park, N. J., 1948. Paper, 8¾ × 11¼ in., paged in sections, illus., diagrams, charts, tables, $4.50. Designed for those who have once studied the subjects included, this review course presents the fundamental concepts, methods, and practical applications of the basic engineering sciences, including hydraulics, thermodynamics, and machine design. For the most effective use, the material has been restricted to the essentials needed for the comprehensive collection of sample problems given. Detailed solutions are worked out for a wide variety of these problems.

ROTARY-VALVE ENGINES. By M. C. I. Hunter. John Wiley & Sons, Inc., New York, N. Y., 1946. Cloth, 5¼ × 8¼ in., 216 pp., illus., diagrams, charts, tables, $5. This book, now available from an American publisher, is a reprinting of a British book previously reviewed as follows: The author describes the general principles and applications of the rotary valve in detail, and draws comparisons between it and the poppet valve for use on internal-combustion engines. The development of the rotary valve up to the present time is also discussed with descriptions of various rotary and semirotary systems applied to various types of old and modern engines—steam, gas, and gasoline. A brief final chapter presents the author's conjectures on the future development of the rotary valve.

STEAM, AIR AND GAS POWER. By W. H. Severns and H. E. Degler. Fourth edition. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, Ltd., London, England, 1948. Cloth, 509 pp., illus., diagrams, charts, tables, $4.75. This standard text gives the student of power engineering the basic infor-

mation he will use in his daily work. It presents modern practice with sufficient technical detail and mathematical calculation. Clear discussions and illustrations show the underlying theory of the construction, applications and performance of modern heat-power plants, and their correlated equipment. New material on the gas turbine and other recent developments has been added to this edition including new problems.

TABLES OF BESSEL FUNCTIONS OF FRACTIONAL Order, prepared by the Computation Laboratory of the National Applied Mathematics Laboratories, National Bureau of Standards, vol. 1. Columbia University Press, New York, N. Y., 1948. Cloth, $7^3/_4 \times 10^3/_4$ in., 413 pp., $7.50. The purpose of this book is to provide tables of Bessel functions of fractional orders, other than one half, which frequently occur in practical applications. The fractional orders of $^1/_4$, $^1/_3$, $^2/_3$, and $^3/_4$ are given to either ten decimal places or ten significant figures. A bibliography on Bessel functions is also included. The present volume contains tables of $J_\nu(x)$, while a companion volume, to be published later, will give the tabulation of $I_\nu(x)$.

THEORETICAL AERODYNAMICS. By L. M. Milne-Thomson. D. Van Nostrand Co., Inc., Toronto, Canada; New York, N. Y.; and London, England, 1947. Cloth, $6^1/_2 \times 10$ in., 363 pp., diagrams, charts, tables, 40s. Based on lectures given at the Royal Naval College, this book discusses the assumptions used in studying the air flow around aircraft. It brings these assumptions to explicit statements and then examines what can be deduced from them. After preliminary discussion, the theory of two-dimensional airfoils is considered. Three-dimensional airfoils, the effect of compressibility of air in subsonic and supersonic flow, and the aircraft as a whole are subsequently considered. About 300 exercises, 260 diagrams, and appropriate references to the literature are also included.

TOOL STEEL SIMPLIFIED. By F. R. Palmer and G. V. Luerssen. Revised edition. Carpenter Steel Company, Reading, Pa., 1948. Cloth, 6 × 9 in., 564 pp., illus., diagrams, charts, tables, $2, U.S.A.; $2.50, foreign. Intended for the man who makes tools, this handbook of modern practice, presents in simple and accessible form the technical and metallurgical knowledge possessed by the steel expert. Outstanding features are sections on the selection of tool steel for each kind of tool, the properties, heat-treatment, and testing of tool steel, and other practical information. In this revised edition, new methods, new terms, and new principles are included. Tool-steel types are based on the "matched-set" classification developed by the company.

WORKSHOP YEARBOOK AND PRODUCTION ENGINEERING MANUAL (II). Edited by H. C. Town. Paul Elek Publishers Ltd., London, 1947. Cloth, $5^1/_2 \times 8^3/_4$ in., 568 pp., illus., diagrams, charts, tables, 35s. This book provides data valuable to the production engineer, the designer, and the engineering student. It is divided into three sections, the first consisting of a series of specialized articles on modern machine-tool developments. Section 2 covers a wide field of engineering progress, including power transmission, industrial developments, precision tools and methods of machining, and offers descriptions of the latest machine tools. In Section 3 are abridged articles from British and American sources providing the latest information on machine design, press operations, gaging and inspection, metal and heat-treatment, welding, electric, and other drives, and controls.

ASME BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code may communicate with the Committee Secretary, ASME, 29 West 39th St., New York 18, N. Y.

The procedure of the Committee in handling the Cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are then sent by the Secretary of the Committee to all members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and is passed upon at a regular meeting.

This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval after which it is issued to the inquirer and published in MECHANICAL ENGINEERING.

Following is a record of the interpretations of this Committee formulated at the meeting of June 25, 1948, the meeting of the Executive Committee on July 8, 1948, and approved by the Council on August 6 and 8, 1948.

CASE NO. 1022 (*Reopened*)

(*Interpretation of Par. Q-205*)

Inquiry: Par. Q-205 of the Code requires welding-operator tests for groove welds to be made in materials $^3/_8$ in. in thickness and that when using pipe or tubing, the nominal diameter shall be not less than 6 in. Is it mandatory that these values be adhered to in all cases?

Reply: The tests described in Part II of the Welding Qualifications Section of the Code are intended for universal qualification of a welding operator and the thicknesses designated were chosen for that purpose.

In arc welding, material having a thickness less than $^3/_8$ in. may be used but in that case the operator shall not be considered qualified for a thickness greater than twice that used in the tests.

In gas welding, material having a diameter less than 6 in. may be used, but in that case the operator shall not be considered qualified for any greater thickness than that used in the tests. Where thicknesses other than $^3/_8$ in. and diameters smaller than 6 in. are as welded, the curvature of the specimen to be tested in the jig may be decreased by machining off the weld reinforcement and by machining the underside of the specimen flat without decreasing the thickness of the specimen at its longitudinal centerline.

If the thickness of the test specimen is other than $^3/_8$ in., the testing shall be done in a guided-bend test jig with the plunger and die member proportioned as follows:

Thickness of plunger member = 4 × thickness of test specimen
Radius of plunger member = 2 × thickness of test specimen
Width of opening, die member = 6 × thickness of test specimen plus $^1/_8$ in.
Radius of die member = 3 × thickness of test specimens plus $^1/_{16}$ in.

In the case of pipe or tubing having dimensions such that testing in a guided-bend test jig cannot be done satisfactorily, the specimen shall be prepared by simulating the full procedure proposed for the actual work to be done. This specimen shall be of the dimensions and tested as shown in Fig. 43. When so tested, the

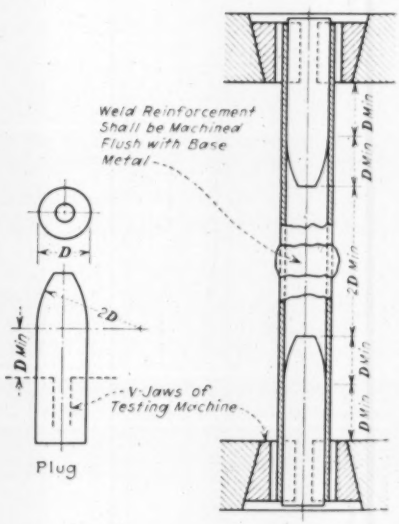


FIG. 43 TENSION SPECIMEN

specimen shall develop the full specified minimum tensile strength of the annealed base material (minimum of the range), when tensile strength is covered in the material specification involved.

CASE No. 1077

(Special Ruling)

Inquiry: May nickel steel tubes having the following analysis and mechanical properties be used in unfired pressure vessels for service at temperatures not over 650 F:

Carbon, max, per cent	0.20
Manganese, per cent	0.30–0.60
Phosphorous, max, per cent	0.04
Sulphur, max, per cent	0.04
Silicon, max, per cent	0.35
Nickel, per cent	3.25–3.75
Tensile strength, min, psi	60,000
Yield point, min, psi	30,000
Elongation in 2 in., min, per cent	30

In all other respects the tubes will comply with Specification SA-213 for ferritic tubes.

Reply: It is the opinion of the Committee that steel tubes complying with Specification SA-213 for ferritic tubes, but with modified chemistry and physical properties as stated in the inquiry, may be used in the construction of pressure vessels under the rules in Section VIII of the Code, using a working stress in Table U-2 of 12,000 psi for temperatures not over 650 F. For temperatures lower than —20 F, the requirements of Pars. U-140 to U-142 must be met.

Proposed Revisions and Addenda to Boiler Construction Code

IT IS the policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revisions of the rules and its Codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the Code, to be included later in the proper place.

The following proposed revisions have been approved for publication as proposed addenda to the Code. They are published herewith with corresponding paragraph numbers to identify their location in the various sections of the Code and are submitted for criticism and approval from anyone interested therein.

It is to be noted that a proposed revision of the Code should not be considered final until formally adopted by the Council of the Society and issued as pink-colored addenda sheets. Added words are printed in SMALL CAPITALS; words to be deleted are enclosed in brackets [ ]. Communications should be addressed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York 18, N. Y., in order that they may be presented to the Committee for consideration.

Par. P-109(**a**). Revise as follows:

(**a**) All fusion welded drums and other fusion welded pressure parts shall be subjected to a hydrostatic test pressure of not less than 1.5 times the maximum allowable working pressure.

PAR. P-113. Delete the last sentence of ther paragraph beginning with "A hydrostatic test shall be made at twice..."

PAR. P-112(**c**). Delete the following: "Piping fabricated in accordance with this paragraph shall be subjected to a hydrostatic test of not less than $1\frac{1}{2}$ times the maximum allowable working pressure." Par. P-329 as recommended above would cover this.

PAR. P-329. Delete that part of the first sentence after the words "maximum allowable working pressure" and beginning with "except that boilers, with welded drums..."

PAR. P-186(**e**)(1). To be deleted, and the subsequent items renumbered.

PAR. U-1(**a**). Revise second section to read:

EXCEPT FOR VESSELS DEFINED IN PAR. U-2(**d**) AS UNFIRED STEAM BOILERS, compliance with Par. U-65 is not required for vessels of: (remainder of paragraph same as in present Code)

PAR. U-2(**d**) and fourth paragraph of Preamble to Section I. Revise as follows:

Unfired pressure vessels in which steam is generated shall be classed as unfired steam boilers with the following exceptions:

(**1**) Vessels known as evaporators or heat exchangers,

(**2**) Vessels in which steam is generated incidental to the operation of a processing system, containing a number of pressure vessels, such as used in chemical and petroleum manufacture.

Unfired steam boilers shall be constructed under Section I or under Section VIII. If built under Section VIII, unfired steam boilers shall be constructed under:

(**1**) Par. U-68 or U-200 for any pressures; or

(**2**) Par. U-69 or U-201 for pressures of 50 psi or less.

TABLE Q-5. Change the heading for classification "P" Number 4—"O" Number 1 to read:

"P" Number 4—"O" Number 1

TABLES P-7 and U-2. Add the following stresses for the specifications indicated:

	For metal temperatures not exceeding deg F					
	—20 to 650	700	750	800	850	900
SA-158 Grade P8d	15000	15000	14600	14300	14000	13400
SA-182 Grade F8m	15000	15000	14600	14300	14000	13400
SA-182 Grades F8c and F8t	15000	15000	14600	14300	14000	13400
	950	1000	1050	1100	1150	1200
SA-158 Grade P8d	12300	10000	8000	8000	4600	3600
SA-182 Grade F8m	12600	11200	9000	7000	5000	3600
SA-182 Grades F8c and F8t	12300	10000	8000	6000	4600	3600

(Experience has indicated that it is advisable to preheat to at least 350 F when welding the material included in this group.)

Under "P" Number 3—"O" Number 1, second paragraph, change parenthetical expression to read: "(Experience has indicated that it is advisable to preheat to at least 350 F when welding the materials included in this group.)"

PAR. H-83. Revise to read:

H-83 When stays are to be attached by fusion welding to plates which, by these rules, require staying the attachment shall meet the following requirements:

(**1**) The stays shall be inserted into holes through the sheets except as provided in (**3**). The size of the fillet weld attaching the stay to the plate shall be not less than the thickness of the plate being stayed, except for plates thicker than $\frac{3}{8}$ in., in which case the size of the fillet weld shall be $\frac{3}{8}$ in. To provide for the above specified welding the plates may be countersunk by machining or pressing, or the stays may protrude through the plates, or a combination of these methods may be used. The area of the weld in shear, measured parallel to that portion of the stay in or extending through the plate shall be not less than 1.25 times the required cross-sectional area of the stay.

(**2**) The ends of stays inserted through plates shall not project more than $\frac{3}{8}$ in. beyond surfaces exposed to the products of combustion.

(**3**) Diagonal stays may be attached to the inner surface of the shell, but not the head, by fillet welds only provided:

(*a*) The size of the welds is not less than the shell plate thickness;

(*b*) The cross-sectional area of the portion of the stay welded to the shell and also the cross-sectional area of the fillet welds parallel to the axis of the shell measured at the throat are not less than 1.25 times the required cross-sectional area of the stay and further provided that such fillet welds shall continue the full length of the side of the stay in contact with the shell;

(*c*) The longitudinal center line of the stay (projected if necessary) shall intersect the inner surface of the plate to which the stay is attached within the outer boundaries of the attaching welds (also projected if necessary).

(**4**) The welding shall be done in such a manner that excessive weld deposits do not project through the surface of the plate at the root of the weld.

THE ENGINEERING PROFESSION

October News and Notes

As Compiled and Edited by A. F. Bochenek

A New Service

NEWS and Notes on the Engineering Profession is the introduction of a new service to readers of this journal. Each month these pages will endeavor to present briefly news of interest to engineers as it develops. Since this is the journal of The American Society of Mechanical Engineers, some part but by no means the major part of this space will concern itself with what is happening in the ASME. The emphasis, however, will be on trends of importance to engineers as they take shape on the economic, political, and professional fronts. News of significance will be treated more fully in the following pages.

Job Opportunities

THE current high level of industrial activity coupled with shortages of college-trained men caused by the war, promises excellent opportunities for the next crop of graduates. Not only engineers but graduates in the liberal arts and business administration may expect high salaries in the face of a sustained demand for their services from business and industry.

This year the General Electric Company hired a record number of 1400 graduates of which 1046 were electrical, mechanical, and industrial engineers (page 852). According to the *New York Times*, starting salaries at Rutgers University were 12 per cent higher in 1948 than last year. Engineering graduates averaged $265 with a top of $325 going to a graduating ceramist. Nonengineers averaged $250 with a high of $275. According to a Rutgers official, the demand will continue for at least three years.

For older men, too, the outlook is encouraging. The traditional barriers against age are breaking down in most industries, according to a survey made by the industrial-relations division of the National Association of Manufacturers. For many capable engineers, the life that begins at forty may no longer be the limbo of prewar years. Federal authorities estimate that 3,000,000 more employees between 45 and 65 years of age are now employed than in 1942.

Collective Bargaining

BY their decision to ask exclusion from the provisions of an act recently enacted by the Canadian Parliament, Canadian engineers joined their colleagues across the border in demanding for members of the engineering profession, freedom from union coercion.

The new legislation known as "An Act to provide for the Investigation, Conciliation, and settlement of Industrial Disputes" specifies that "a member of the medical, dental, architectural, engineering, or legal professions, qualified to practise under the laws of the province and employed in that capacity" is excluded from provisions of the act.

The decision to ask for exclusion was taken by the Council of The Engineering Institute of Canada after being informed by legislators that their wishes would be incorporated in the new law. During the hearings the issue was a hot one because many engineers favored inclusion. Eventually all the major engineering bodies in Canada dropped their opposition and a solid front in behalf of the profession was presented to legislators.

Canadian engineers will remember this act for two things: As the first time their government recognized engineering as one of the professions; and as one of the few occasions of unanimity when all engineering organizations "were singing the same tune out of the same hymn book."

Frank T. Sisco, in a recent issue of *Mining and Metallurgy*, calls attention to a new ruling of the National Labor Relations Board which further protects professional employees from union coercion.

In answer to a petition for a decertification election filed by engineers of the Illinois Bell Telephone Company of Chicago, the NLRB ruled recently that the provision of the Taft-Hartley Act, prohibiting coercion of professional employees into joining unions, also applies in the case of where a minority group of professional employees in a heterogeneous bargaining group determine to sever relations and establish their own organization.

British Quality Production

A recent statement to the press by a prominent American engineer that "the British want to make things better, not faster," epitomizes a fundamental difference between British and American industry.

In pursuit of the American ideal of more goods for more people, the elusive thing called quality suffers a pounding from demands for more production at lower unit cost. The standard of quality in an engineering product, like the standard of taste in literature and the other arts, must be sustained constantly by examples which can be seen, touched, and enjoyed, otherwise a newer and lower standard is accepted as the old examples are blurred by time and fade from memory. Already a host of industrial products along with homes have slipped down the scale of quality.

British engineers and the industry they guide can perform a valuable service to American industry by remaining faithful to their tradition of quality production. By producing products for the few, they will provide a goal for quality for those who produce for the many. It should be a reminder that the prevailing compromise between cost and quality is but the last stop on the road to more and better things.

Young Profession

INDUSTRIAL leadership of Western Europe in the nineteenth century and the relative youth of the engineering profession stand out in the recent centennial celebrations held by four European engineering societies.

Last year in June, The Institution of Mechanical Engineers of Great Britain passed the century mark, and in September the Netherlands Institution of Engineers was host to engineers from

both hemispheres on a similar occasion. In 1948 centennial celebrations were held by the Société des Ingenieurs Civil de France, and the Austrian Society of Architects and Engineers (page 853).

While European engineers in the late 1840's were establishing a new profession, their American colleagues were following their progress with interest. In 1852 the American Society of Civil Engineers was organized. Other Societies followed: AIME in 1871, ASME 1880, AIEE 1884, and AIChE 1908.

American Technology

EUROPEAN interest in American technology should not give American engineers the idea that they are superior to Europeans, according to John A. Willard, whose article, "Europe Looks to America for Technological Assistance" appears in this issue. Gas turbines and jet engines, two of the major engineering developments of the past decade were first developed in Europe. American technology, if it is imported, will be transformed to meet the social, religious, political, and economic conditions of the Old World.

AT a recent meeting of the National Research Council's Division of Engineering and Industrial Research, a proposal was made that members of the Division meet with presidents and secretaries of national engineering societies to discuss co-ordination of American research projects (page 853).

Carleton Shugg has been appointed Deputy General Manager of the Atomic Energy Commission (page 852).

The Committee for Economic Development, which for the past several years has been contributing important studies on American economy as a public service, recently announced a new chairman of its Research and Policy Committee and a new six-point program covering such topics as safeguards against economic instability and how to raise real wages (page 852).

WITH its membership no longer confined to Manila and its suburbs, the Philippine Association of Mechanical and Electrical Engineers has taken a step characteristic of a growing association. It is publishing its own quarterly, the *PAMEE Engineering Journal*. Articles on reconstruction and democratic planning are featured in the first issue (page 851).

FOR more than ten years the ASME and AIME, engineering societies concerned with the technology of extracting and utilizing solid fuels, have been promoting understanding between coal producers and consumers. Their eleventh joint conference will be held at White Sulphur Springs, W. Va., Nov. 3-4, 1948 (page 851).

THE National Council of State Boards of Engineering Examiners reported at its recent annual meeting that about 127,000 engineers were registered in the United States and its territories on June 30, 1948. With membership of constituent societies of the Engineers Joint Council just rounding the 100,000 mark, and many of these not yet registered, it appears that many qualified engineers either find no benefit in membership in the traditional engineering societies or take advantage of available services without contributing to the support of them (page 852).

TRAINING of engineering graduates by industry for industrial management has been designated as the theme of the 1948 Annual Meeting of The American Society of Mechanical Engineers (page 850).

Nuclear Research

SUBSTANTIAL improvement of U. S. atomic weapons is reported in the Atomic Energy Commission's Fourth Semiannual Report to Congress. Under conditions approaching laboratory control three nuclear explosions were studied. Sixty particle accelerators are now in use and their number will soon be doubled by construction already scheduled. For high lights of the report see pages 820 and 821 of this issue.

Student Branches

IN the past 12 months student membership in The American Society of Mechanical Engineers increased from 10 to 15 thousand. This increase is significant because it means that engineering students consider the Society's program on the campuses worth the three dollars they are asked to pay in dues.

Undoubtedly, the increase is due in part to the large enrollment of veterans now passing through the academic program like the crest of a wave. These are earnest men intent on making up for time sacrificed in defense of the nation. That they should find the Society's student program helpful in preparing for a professional career should be a satisfaction to members whose dues subsidized the program to the tune of 25 per cent.

How much the Regional administration has contributed to the growing student membership is an interesting speculation. Certainly the Regional Student Branch Committees, because of their number and proximity to the engineering schools, have the opportunity of making knowledge of ASME affairs a part of every mechanical-engineering student's campus experience. At headquarters an increase in the frequency with which student-branch reports mention participation by members in campus meetings has been noted. Meetings sponsored jointly by Sections and near-by student branches are not uncommon. Some sections add spice to these events by making them the occasion for competitive presentation of papers with prizes of handbooks and junior memberships as the "take."

More spectacular, though no more important, are the student-branch conferences held annually in each Region of the Society. These conferences in which the schools, members of the ASME, and industry are increasingly taking a part, dramatize the member-student relationship and the responsibility the engineering profession feels toward the young man preparing for the profession.

Such contributions in time and money are apparently appreciated by students. They give meaning to the Society's professed interest in the preprofessional young man. They also build value into the student-branch program, the kind of value, intangible though it is, that earnest young men are beginning to recognize. The ASME has reason to be thankful to those members who have made the student-branch program one in which the Society can take pride.

Junior Forum

IN this issue the Junior Forum begins its second year as a project of the ASME Junior Committee. The Forum is designed to encourage junior participation in the affairs of the Society and "to facilitate the self-expression of juniors in their efforts to resolve the problems that confront them." During the summer, B. H. Edelstein assumed chairmanship of the editorial committee of the Metropolitan Section junior members who are in charge of the project. National representation on this committee is needed if the Forum is to accomplish its purposes. Junior members are urged to give it their support (page 858).

ASME NEWS

And Notes on Other Engineering Societies

Training Graduates for Management to Be Theme of ASME 1948 Annual Meeting Nov. 28–Dec. 3, 1948

Headquarters: Hotel Pennsylvania

TRAINING of engineering graduates by industry for industrial management will be the theme of the 1948 Annual Meeting of The American Society of Mechanical Engineers to be held at the Pennsylvania Hotel, Nov. 28–Dec. 3, 1948. This theme is to be developed in several technical sessions and social events, beginning with the keynote luncheon on Monday, Nov. 29, at which L. A. Appley, president of the American Management Association, will speak on "Opportunities for and Responsibilities of the Young Engineer in Industry."

As main speaker at the banquet scheduled for Wednesday, Dec. 1, Pres. E. G. Bailey will use a similar subject. President Bailey has addressed many ASME Sections during the year on the challenge to engineers of the unsolved engineering problems which face the nation. He has a deep interest in the welfare of young engineers and has contributed much to the recent report of Subcommittee on Survey of Employer Practice Regarding Engineering Graduates of the Engineers Joint Council of which he was chairman.

Other sessions on "Creative Engineering" and "Opportunities for the American Engineer Abroad" are expected to be sponsored jointly by the Education Committee and the Management Division.

While plans for some of the events have already been made, it is still too early to list papers and authors or to report the chronological pattern of the program. The tentative program containing the last-minute information will be published in the November issue of MECHANICAL ENGINEERING.

1948 Honors

The traditional ceremonies at the banquet will be the recognition of fifty-year members of the Society and the presentation of honors and awards. The John Fritz Medal will be presented to Theodore von Kármán, director, Guggenheim Aeronautical Laboratory, California Institute of Technology, Pasadena, Calif., in recognition of his work as "a creative leader, stimulating teacher, and wise counselor in engineering and physical research in the fields of the aeronautical and structural sciences, and for his many applications of mathematical and physical theory to the sound solutions of engineering problems." Among other awards to be presented will be: *ASME Medal*, Fred G. Keyes, head of department of chemistry, Massachusetts Institute of Technology, Cambridge, Mass.

Worcester Reed Warner Medal, Edward S. Cole, president, Pitometer Log Corporation, New York, N. Y.

Melville Medal, R. E. Gillmor, vice-president, Sperry Corporation, New York, N. Y., for paper on "The World the Manager Lives In."

Junior Award, Hunt Davis, division engineer, aerodynamics division, Research and Development Department, Elliott Company, Jeannette, Pa., for his paper "A Method of Correlating Axial-Flow-Compressor Cascade Data."

Pi Tau Sigma Gold Medal, Walter G. Vincenti, Ames Aerodynamic Laboratory, Mountain View, Calif. Honorable Mention, William C. Parrish, General Electric Company, Schenectady, N. Y.

Hotel Room Reservations

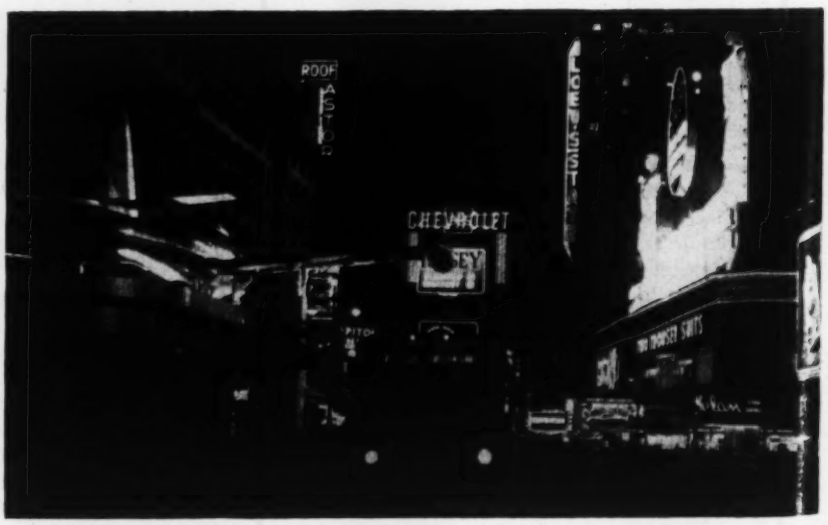
Annual Meeting hotel rooms at the Pennsylvania Hotel must be reserved so that the hotel will be in receipt of the essential information not later than Nov. 19, 1948. Please state type of room, names of occupants, expected time, date of arrival, and also departure.

College Reunions

Members who attended the Atlantic City meeting last year and missed the fun of meeting old friends at college reunions will be glad to know that this feature of New York annual meetings will be a part of the 1948 program. Members who wish to initiate reunions should write to headquarters for information about luncheons, speakers, locations, and meal prices as soon as possible. The registration desk at the meeting will have a schedule of the reunions which will be planned.

Preprints

Since technical sessions cannot be fully appreciated without benefit of preprints, every effort is being made by the staff to facilitate the purchase of these in advance of sessions. The tentative program will identify each paper by a preprint code number. These numbers simplify handling of large numbers of papers because numbers are less confusing than names of authors and long titles. There will also be available a convenient order form designed to permit members to order papers they want with only a few strokes of the pencil. For members who may order papers by mail, the coupon books introduced last year should not be overlooked. Use coupon books and avoid the tyranny of the checkbook and postal money orders. Watch the tentative program for preprint numbers, and do not overlook the convenience of coupon books.



NEW YORK CITY'S TIMES SQUARE AT NIGHT, LOOKING NORTH FROM 43RD STREET

Tentative Program of the Eleventh National Fuels Conference to Be Held at White Sulphur Springs, W. Va., Nov. 3–4

STATUS of the nation's coal reserves and research progress on synthetic liquid fuels will be among the subjects discussed at the Eleventh National Fuels Conference to be held at the Greenbrier Hotel, White Sulphur Springs, W. Va., Nov. 3–4, 1948. The Conference is sponsored jointly by the Coal Division of the American Institute of Mining and Metallurgical Engineers and the Fuels Division of The American Society of Mechanical Engineers with the co-operation of the AIME Central Appalachian Section. An attendance of 300 engineers is expected.

In 1937 the need for better understanding of the interlocking problems of coal producers and coal consumers led the ASME and the AIME, the Founder Societies directly interested in technology of extracting and utilizing solid fuels, to sponsor the first National Fuels Conference in Pittsburgh, Pa. Except in 1945 when travel restrictions made the conference impracticable, similar conferences have been held in various industrial centers: Chicago, Ill., 1938; Columbus, Ohio, 1939; Birmingham, Ala., 1940; Easton, Pa., 1941; St. Louis, Mo., 1942; Pittsburgh, Pa., 1943; Charleston, W. Va., 1944; Philadelphia, Pa., 1946; and Cincinnati, Ohio, 1947.

A feature of the Conference will be the presentation of the Percy Nicholls Award for 1948 to Ralph S. Sherman, assistant director, Battelle Memorial Institute, Columbus, Ohio. The award is made annually for "notable scientific or industrial achievement in the field of solid fuels." Mr. Sherman was recently elected director at large of The American Society of Mechanical Engineers for a four year term.

The Tentative Program

WEDNESDAY, NOVEMBER 3

9:00 a.m.

Registration

10:00 a.m.

Session I

Work of the Geological Survey on Coal and Coal Reserves, by Paul Averitt, Mem. AIME, U. S. Geological Survey, Washington, D. C.

Coal and Synthetic Liquid Fuels, by J. D. Doherty, Mem. AIME, U. S. Bureau of Mines, Washington, D. C.

12:15 p.m.

Luncheon

Speaker: G. R. Spindler, Mem. AIME, European technical adviser, Joy Manufacturing Company, Brussels, Belgium.

Topic: Mechanical Mining in Europe

6:30 p.m.

Banquet

Joint ASME-AIME presentation of Percy Nicholls Award for 1948 to Ralph A. Sherman, Mem. ASME and AIME, assistant director, Battelle Memorial Institute, Columbus, Ohio

Speaker: E. G. Bailey, president ASME.

Topic: Opportunities in the Field of Fuels

THURSDAY, NOVEMBER 4

9:30 a.m.

Session II

Organizing and Financing Co-Operative Research, by Elmer R. Kaiser, Mem. ASME, assistant director of research, Bituminous Coal Research, Inc., Columbus, Ohio

An Evaluation of Residential Stoker Coals, by Harlan W. Nelson, supervisor, and James B. Purdy, Mem. ASME, research engineer, Battelle Memorial Institute, Columbus, Ohio

Coal Dock Operations of the North-Western-Hanna Fuel Company at the Head of the Lakes, by J. T. Crawford, Mem. AIME, general superintendent of docks, North-Western-Hanna Fuel Company, Duluth, Minn.

12:15 p.m.

Luncheon

2:30 p.m.

Session III

Correlation of the Performance Characteristics of Domestic Stoker Coals With Their Chemical and Petrographic Composition, by R. J. Helfinstine, Mem. ASME, mechanical engineer, and G. H. Cady, senior geologist and head of coal division, Illinois State Geological Survey, Urbana, Ill.

A Study of Coal Classification and Its Application to the Coking Properties of Coal, by Michael Perch and C. C. Russel, research department, Koppers Company, Inc., Kearney, N. J.

Philippine Engineers Start Engineering Journal

THE first issue of the *PAMEE Engineering Journal* published by the Philippine Association of Mechanical and Electrical Engineers was recently received. The publication is 6 × 9¼ in. containing 66 pages of editorial text and advertising. It is to be published quarterly.

Setting the tone of editorial content are articles on "The Importance of Electrical Construction in Philippine Rehabilitation" and "Democratic Planning in a Modern World."

Florencio Unson, president PAMEE, in an introductory editorial hailed the *Journal* as a symbol of the growth of the engineering profession in the Philippines and a new medium for interchange of ideas among members of the association whose membership has spread beyond the limits of Manila and its suburbs.

1949 ASME Mechanical Catalog and Directory

THE thirty-eighth annual ASME Mechanical Catalog and Directory, 1948 edition, was distributed to ASME members during October.

In its catalog section, manufacturers describe and illustrate many products of interest to

ASME Calendar

of Coming Events

Oct. 3–6, 1948
ASME Petroleum Division Conference, Herring Hotel, Amarillo, Texas.

Oct. 14–15, 1948
ASME Wood Industries Division Conference, Sheraton Hotel, High Point, N. C.

Nov. 3–4, 1948
ASME Fuels Division—AIME Coal Division Conference, Greenbrier Hotel, White Sulphur Springs, W. Va.

Nov. 28–Dec. 3, 1948
ASME Annual Meeting, Hotel Pennsylvania, New York, N. Y.

Jan. 10–14, 1949
ASME Materials Handling Division and Management Division Conference, Convention Hall, Philadelphia, Pa.

Apr. 25–29, 1949
ASME Oil and Gas Power Division Conference, Hotel Sherman, Chicago, Ill.
(*Final date for submitting papers—Dec. 1, 1948*)

May 2–4, 1949
ASME Spring Meeting, New London, Conn.
(*Final date for submitting papers—Jan. 1, 1949*)

June 27–30, 1949
ASME Semi-Annual Meeting, San Francisco, Calif.
(*Final date for submitting papers—Feb. 1, 1949*)

Sept. 28–30, 1949
ASME Fall Meeting, Erie, Pa.
(*Final date for submitting papers—May 1, 1949*)

Nov. 27–Dec. 2, 1949
ASME Annual Meeting, New York, N. Y.
(*Final date for submitting papers—Aug. 1, 1949*)

(*For Meetings of Other Societies see page 853*)

mechanical engineers. This section is followed by a Directory which gives the user a practically complete and authoritative index to the following markets: Metals and alloys, power-plant equipment, power-transmission equipment, instruments, materials-handling apparatus, aircraft power plants and instruments, foundry and machine-shop equipment, heating, ventilating, and air-conditioning equipment, electric motors and controls, equipment for process industries, pumps, fans, compressors, and many other types of mechanical apparatus. A page-reference system in the Directory ties in with the catalog section providing descriptions of the desired machine or equipment.

According to the editors of the volume, it is the only book which covers the field of mechanical engineering so thoroughly.

A 20-page insert describing all ASME publications, such as power test, boiler construction, and safety codes, American Standards, fluid meters, engineering biographies, bibliographies, research reports, and manuals, is included in this volume for the ready reference of ASME members.

Engineering Examiners Hold Annual Meeting

IN June 30, 1948, 127,899 persons were registered as engineers, and 9439 as land surveyors in 48 states and three territories, according to a report presented at the 27th annual meeting of the National Council of State Boards of Engineering Examiners held at Salt Lake City, Utah, Aug. 26–27, 1948. Thirty eight of the 51 states and territories were represented by 83 members of the various state boards.

Other reports revealed that seventeen states which have adopted the engineer-in-training program have made good progress in putting it to work. This program permits the first step in registration to be accomplished by examination upon graduation from an engineering school. Reciprocal relations as to registration procedures between states are still confusing but progress was made in reducing the confusion. A misunderstanding was rumored as to the purpose of the certificate issued by the National Bureau of Engineering Registration. Good progress was also reported in clarifying the procedures for written and oral examinations and for measuring qualifying experience. There was noticeable unanimity in spirit and action.

The first day of the meeting was devoted to group meetings of the four zones in which the Council is organized and to meetings of standing committees. The second day the Council met in plenary session and received and discussed reports of the officers and committees. The proceedings of the meeting, to be issued soon, will contain the complete record of the reports and discussion. One report of interest gave a statement of requirements and limitations to be met by engineers from the United States of America in temporary practice in Latin-American countries and the Philippines.

Praiseworthy recognition was made of the completion of twenty-five years of service as executive secretary by T. Keith Legaré, of Columbia, S. C.

New officers elected to take office at the close of the meeting were: President, Alexander Blair, Lake Placid, Fla; vice-president, Clarence L. Eckel, Boulder, Col.; director western zone, Paul E. Jaffers, Los Angeles, Calif.; director southern zone, N. W. Dougherty, Knoxville, Tenn. The Board of Directors of the Council, until the next meeting, will consist of these officers and past-president George M. Shepard, St. Paul, Minn.; director central zone, Walter W. Graf, Lancaster, Ohio; and director eastern zone, Russell G. Warner, New Haven, Conn., Mem. ASME.

A distinguished-service certificate was presented to C. L. Mann, Raleigh, N. C., for twenty years of service on the North Carolina State Board of Engineering Examiners.

The 1949 meeting will be held at Daytona Beach, Fla, during Nov. 3, 4, and 5, 1949, and the 1950 meeting at Chicago, Ill., at a date to be selected by the Board.

C. E. Davies, secretary ASME, represented the Society at the meeting.

CED Announces Expanded Research Program

ELECTION of Philip R. Reed, chairman of the board of the General Electric Company, as chairman of the Research and Policy Committee of the Committee on Economic Development was recently announced at a press conference in the Waldorf-Astoria Hotel, New York, N. Y.

After introductory remarks by W. Walter Williams, chairman CED, Mr. Reed described six projects of an enlarged research program recently laid out by the CED as part of its new and permanent basis of operation. These projects are: (1) Safeguards against extremes of economic instability through fiscal and monetary policy to combat inflation and deflation; (2) how to raise real wages by putting more purchasing power in the pay envelope; (3) Federal tax policy for 1949; (4) international economic readjustment; (5) allocation of resources in a defense economy; and (6) how to keep our economic and individual freedoms in a garrison state.

In reply to questions Mr. Reed said that a permanent basis of organization has given the group new forward impetus. He stated that he felt deeply that American businessmen who have the day-by-day experience in the workings of our economic system have also the responsibility for improving it.

The CED is a group of top-flight business leaders organized to study the American system of free enterprise. The work of the Committee is done in three stages. After research projects are decided upon, a permanent and part-time research staff is set to work to gather background materials. An advisory group of ten nationally known economic experts is enlisted to survey research results. With these studies in hand the CED Research and Policy Committee composed solely of working businessmen sit down together to draft a policy statement on the question under study. The result is an objective statement on some major economic problem facing the nation, contributed as a public service for guidance of the public and legislators.

GE Hires Record Number of Engineering Graduates

A RECORD number of more than 1400 graduates of 150 colleges and universities have been hired by the General Electric Company this year, surpassing by almost 600 the previous high mark of last year.

Expansion of the company, coupled with the effects of the wartime shortage of graduates, led to selection of this record number, according to Maynard M. Boring, Mem. ASME, assistant to the vice-president in charge of engineering policy.

Of this group, 1046 are electrical, mechanical, and industrial engineers.

Atomic Energy Commission Realigns Headquarters Staff Duties

THE Atomic Energy Commission announced recently the appointment of Carleton Shugg, manager of the Commission's operations at Hanford, as deputy general manager, and outlined certain new assignment of duties to staff divisions at the headquarters office in Washington.

In the newly created position of deputy general manager, Mr. Shugg will co-ordinate and expedite the technical and scientific phases of the Commission's widespread operations.

Carroll L. Wilson, general manager, commented that the new appointments will bring wider industrial experience and direction into the headquarters organization while continuing the high standard of management experience and competence at Hanford, the largest production and construction operation in the atomic-energy program. He stated also that the changes in assignment of headquarters staff duties will provide for more precise fixing of responsibility in each major phase of the program, a consolidation of the executive work load among the general manager's principal assistants, and a simplification of structure of the organization of the Commission's principal office, which by law is located in Washington, D. C.

Mr. Shugg for the past year has managed the operations at Hanford, including the huge existing plutonium-production plant and its expansion through the largest single construction program in the peacetime history of the United States. The contractor at Hanford is the General Electric Company and Mr. Shugg has represented the Commission in all its dealings with the company.

Help Us to Serve You Promptly

ASME members are entitled to 20 per cent discount on purchases of Society publications. When ordering publications please indicate in your correspondence that you are a member. This will permit the Society to serve you more promptly and assure you of the benefit of the discount. Otherwise your order must wait until your membership status is checked through the master membership file.

NRC Seeks to Improve Research Services

At its annual meeting in June, 1948, the Division of Engineering and Industrial Research of the National Research Council took steps to clarify its relationship with constituent societies of the Council.

The action followed a discussion by Detlov W. Bronk, chairman NRC, of the responsibilities and opportunities of the Council in co-ordinating the huge volume of research in which industry, universities, and technical societies are now engaged. The proposed plan calls for a meeting of the members of the NRC Division of Engineering and Industrial Research with the presidents and secretaries of affiliated Societies to discuss the mechanisms of co-ordination which can best serve the purposes of research agencies.

The NRC was established in 1916 by the National Academy of Sciences with co-operation of national scientific and technical societies, including The American Society of Mechanical Engineers, as an agency to stimulate research as a tool of national defense. In recent years the Division of Engineering and Industrial Research has been active in such fields of research as artificial limbs, ship construction, highway research, and studies of quartermaster problems.

The NRC was organized to hold a position in research similar to that of the American Standards Association in standardization. It does not initiate research but when called upon by government or industry, the Council organizes research by calling upon the facilities of its constituent organizations. Its work is financed by Government agencies and industrial organizations who benefit from the research projects.

G. A. Hawkins, Mem. ASME, acting dean, graduate school, Purdue University, Lafayette, Ind., is ASME representative on the Division. C. Richard Soderberg, Mem. ASME, professor, Massachusetts Institute of Technology, was recently appointed chairman of the Division of Engineering and Industrial Research. He succeeds Frederick M. Feiker, Assoc. ASME, dean, school of engineering, The George Washington University, Washington, D. C.

Symposiums Featured at AAAS Centennial Celebrations

Fifteen symposiums and 12 addresses by eminent world scientists under the theme, "One World of Science," were planned for the centennial anniversary meeting of the American Association for the Advancement of Science, held Sept. 13–16, 1948, Washington, D. C.

The choice of September for the centennial celebrations marked a departure from the traditional Christmas holiday meetings of the Association. Instead of a meeting at which scientific papers are presented in the sections and the affiliated societies of the Association, the 1948 meeting consisted of symposiums on the important scientific problems of the day. At each symposium three scientists chosen from different fields contributed co-ordinated papers on chosen topics. At the conclusion of each symposium several scientists chosen for their familiarity with the topic presented discussions. The program by its breadth of treatment effectively covered significant progress in the fields of science.

Of interest to engineers was the symposium on world sources of energy, in which authorities in the fields of atomic energy, photosynthetic energy, and petroleum participated, and a lecture on "Giant Machines for Research."

Austrian Engineers Mark Centennial

Reconstruction problems of Austria and a re-evaluation of engineering contribution to world culture were some of the topics discussed at the centennial celebrations of the Austrian Society of Engineers and Architects held in Vienna, June 3–7, 1948. More than a hundred delegates from foreign universities and technical societies participated in ceremonies and tours which made up the program.

Col. T. A. Weyher, Mem. ASME, assistant military attaché, Berne, Switzerland, represented The American Society of Mechanical Engineers.

Among the reconstruction projects to which Austrian engineers attached significance were the rebuilding and expansion of the Danube harbor at Vienna, the creation of a smaller ministry of reconstruction headed by engineers of high caliber, and recognition by the engineering profession of the function of the sales engineer.

Gold medals of honor of the Austrian Society were presented to eight distinguished Austrian engineers, including Prof. K. Holey for his work in architecture. Professor Holey later addressed the meeting using for his subject, "The Status of Technology as Related to the Questions of Today." Professor Holey's address will be published in an early issue of Mechanical Engineering.

Speakers on Machine Design as a Career Available

A slate of 30 speakers, all of whom have made a career of machine design, has been created by the Machine Design Division of The American Society of Mechanical Engineers as the first step in a program of stimulating interest in the field of machine design among engineering students.

The speakers selected reside in all parts of the United States and are prepared to appear before engineering students at schools in their vicinity.

In describing the rewards and satisfactions that are part of the field of machine design, the speakers will tell of their own experiences, the satisfaction that comes from seeing an idea translated into a finished product, and the nature of the abilities that are required for happiness in the field.

The project is being undertaken to correct an erroneous impression that a career in machine design means a life at the drafting board. Because of this impression, industry has been losing students to other fields of engineering. By describing the careers of successful design engineers to students and by giving them a personal insight into the rewards of the field, the Division believes that students who have shown aptitude will be encouraged to develop their interest in machine design after graduation.

Section and student-branch officers in charge of programs for the fall and winter season who want to engage one of the speakers should write to Headquarters, attention of B. P. Graves, chairman, Committee on Student Talks, ASME Machine Design Division.

Meetings of Other Societies

October 13–15
American Society of Civil Engineers, fall meeting, Hotel Statler, Boston, Mass.

October 14–15
American Institute of Mining & Metallurgical Engineers, petroleum division, fall meeting, Elk's Club, Los Angeles, Calif.

October 18–20
Engineers' Society of Western Pennsylvania, ninth annual water conference, Hotel William Penn, Pittsburgh, Pa.

October 24–29
American Welding Society, annual meeting, Bellevue-Stratford Hotel, Philadelphia, Pa.

October 25–29
American Society for Metals, national metal congress and exposition, Philadelphia, Pa.

October 29–30
Engineers' Council for Professional Development, 16th annual meeting, Hotel Statler, Detroit, Mich.

November 7–10
American Institute of Chemical Engineers, New York meeting, Hotel Pennsylvania, New York, N. Y.

November 8–11
American Petroleum Institute, 28th annual meeting, Stevens Hotel, Chicago, Ill.

November 10–13
The Society of Naval Architects and Marine Engineers, annual meeting, Hotel Waldorf-Astoria, New York, N. Y.

(*For coming ASME Meetings see page 851*)

Engineers Decorated

SEVEN members of The American Society of Mechanical Engineers are among the 65 scientists and engineers who have been awarded the Medal for Merit for wartime service with the Office of Scientific Research and Development. They are: Henry Butler Allen, executive vice-president, The Franklin Institute, Philadelphia, Pa.; Hoyt C. Hottel, department of chemical engineering, Massachusetts Institute of Technology, Cambridge, Mass.; Irving Langmuir, associate director, Research Laboratory, General Electric Company, Schenectady, N. Y.; Edward Leyburn Moreland, senior partner, Jackson and Moreland, Boston, Mass.; Hartley Rowe, vice-president and chief engineer, United Fruit Company, Boston, Mass.; Thomas K. Sherwood, dean of engineering, Massachusetts Institute of Technology, Cambridge, Mass., and Clyde E. Williams, director, Battelle Memorial Institute, Columbus, Ohio.

The Armed Forces are planning ceremonies in the home towns of the recipients at which the awards will be presented.

Tariff on Drawings Favored by Canadian Engineers

EVIDENCE is growing that Canadian engineers in increasing numbers favor restoration of the protective tariff on engineers' drawings coming into Canada, according to the Engineering Institute of Canada.

Since removal of the tariff, many American firms with plants in Canada have been encouraged to turn over to American engineers the designing of plant extensions. This has resulted in loss of business to Canadian engineers, it was stated, and also a loss of American dollars in substantial amounts. Of particular importance is the fact that Canadian industry stands to lose hundreds of thousands of dollars of business because American engineers naturally specify American equipment with which they are familiar.

Arn Normann Awarded Rice Memorial Scholarship

THE 1948 award of the Calvin W. Rice Memorial Scholarship Fund has been made to Arn Normann of Norway by the Woman's Auxiliary of The American Society of Mechanical Engineers.

Mr. Normann was selected through the recommendation of the Institute of International Education. He attended the Oslo Technical School of Norway, and for the past year has been a student in mechanical engineering at the University of Missouri School of Mines and Metallurgy at Rolla, Mo. He was elected to Tau Beta Pi and Phi Kappa Phi. He will study under a scholarship given by Cornell University.

Specifications Institute Organized

A NEW organization dedicated to the improvement of specification writing and practices in the construction and allied industries has been launched here in Washington. It is The Construction Specifications Institute, Incorporated, and is composed primarily of specification writers, architects, and engineers, both in private and public practice.

The object of the Institute will be to compile and analyze statistics and information; to engage in the research and study of new methods and all problems dealing with specification writing, and to establish and maintain a clearinghouse of unbiased technical information on specifications for the fabrication and installation of construction materials and equipment.

Priority goals set by the first permanent officers elected on April 15, 1948, included these: (1) Better specification writing; (2) simpler specifications; (3) standardization of building codes; (4) standardized specifications for public works by the government at all levels; (5) study of new materials and other processes developed during World War II, in order to fit them into the construction picture as substitutes or improvements on costlier and scarce materials, today retarding all government, residence, and commercial construction.

James B. Moore, chief, Specification Review Unit, Division of Hospital Facilities, U. S. Public Health Service, was elected president.

The Institute's principal office will be at 1825 K Street, Northwest, Washington 6, D. C. Dues for active and associate members are $5 per year.

Industrial Exhaust Code to Be Revised

INCREASING recognition by hygienists and engineers that engineering principles can be used to advantage in exhaust-system ventilation to remove toxic fumes and gases, has led to reorganization of the Sectional Committee on Safety Code for Industrial Exhaust and Ventilation. This committee, organized under the procedure of the American Standards Association, is sponsored by the International Association of Industrial Accident Boards and Commissions. Theodore Hatch, Mem. ASME, of the Industrial Hygiene Foundation, Pittsburgh, Pa., is chairman of the reorganized committee.

The work of the committee is being planned around specific operations for which exhaust ventilation is needed rather than for the development of specifications by industries or for the equipment. Ten operations have been agreed upon as the basis for future work. They include mechanical cutting and abrading; surface coating; open-tank operations; solid-materials handling; fuel burning; exhaust gas producing operations; molten-materials handling; welding, burning, and soldering; fiber handling; volatile and gaseous material handling; and chemical-process operations. This list was compiled by a subcommittee working under the leadership of Arthur Stern of the New York Department of Labor, Mem. ASME, who represents The American Society of Mechanical Engineers on the committee.

Keep Your ASME Records Up to Date

HEADQUARTERS depends on its master membership file for answers to hundreds of inquiries daily pertaining to its members. All other Society records and files are kept up to date through changes processed through it. The listings in future ASME Membership Lists will be taken directly from the master file. It is important to you that it lists your latest mailing address and your current business connection.

The mailing form on this page is published for your convenience. You are urged to use it in reporting recent changes.

Your mailing address is important to Headquarters. Please check whether you want your mail sent to home or office address.

ASME Master-File Information

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Eleven Student Branch Conferences End Record 1947–1948 Program

Advantages to Be Gained From Student Participation

SIXTEEN hundred student members of The American Society of Mechanical Engineers took to buses and private cars to take part in 11 Student Branch Conferences held on as many campuses across the nation between April 6 and May 17, 1948. These conferences were the climax to a record year of ASME student-branch activity during which student membership leaped from 10 to 15 thousand and the number of student branches reached 124, or an ASME student organization on every campus which offers a course in mechanical engineering accredited by the ECPD.

Planned and managed by student members, the conferences are in every respect a counterpart of regular Society annual meetings. Their purpose is to promote professional development by bringing together students from near-by schools to compete in presentation of technical papers, to discuss problems of student-branch administration, plan for the next academic year, listen to leaders in industry discuss matters of engineering import, and, generally, to enjoy a social program, luncheons, dinners, and plant-inspection trips.

Broad Participation

Since 1932, when the present plan of student-branch operation was initiated on an experimental basis in Region IV, each spring has seen a growth of the conference idea. Members of ASME sections in the neighborhood of the host schools often attend the conferences as judges of the competitions, or contribute to the program by assisting in the plant-inspection trips, by sponsoring free luncheons, or by offering additional prizes to student speakers. In some sections, Junior groups have found in the conferences an opportunity to present to the students the advantages of ASME membership, but perhaps more exciting from the point of view of the engineering student is the opportunity for employment which the conferences offer, because industrial organizations often send observers to seek talent for engineering staffs. Coming at a time of the year when two thirds of those who attend are about to graduate, when the pressure of four years of intensive study is beginning to slacken, and the doors of industry are opening on every hand, the conferences are the occasions of enthusiastic competition, pleasant associations, and good holiday fun.

Behind each conference are months of planning not only by the host schools, but also by members of neighboring schools who seek out and encourage able members of their groups to write papers that might outshine competition and walk away with the prize money. For each conference the Society offers a first prize of $50, a second of $25, and a third and fourth of $15 and $10, respectively. A fifth prize of $10 is put up by the Old Guard Committee. Sections and local industry often offer additional prizes of technical books or Junior membership in the Society.

A list of 1948 Conferences and winners of the papers competition appears on the following pages.

Student-branch conferences are one of the measures developed by the ASME to aid student engineers in the difficult period of transition from life on the campus and that in industry. As the climax of a well-integrated campus program which enables engineering students to develop a habit of professional action and thought, it is one of the major reasons why engineering students, early in their academic careers, should affiliate themselves with the ASME campus program.

J. CALVIN BROWN, VICE-PRESIDENT, ASME REGION VII, CONGRATULATES WILLIAM SEIDEN, FIRST PRIZE WINNER, REGION VII CONFERENCE HELD AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY, APRIL 23–24, 1948.

(At each of the eleven annual conferences, student members competed in the presentation of technical papers for $110 in prize money offered by the Society. First prize was $50.)

Benefits of Student Membership

A student might well ask how can the ASME help him to develop professionally.

The answer is that the Society provides him with a pattern of action while on the campus which in form and spirit is identical with that which he must follow if he expects to find a place for himself in the engineering profession.

What is this pattern of action that is so important to members of the engineering profession? First, it is the habit of sacrificing personal leisure to attend engineering meetings. Second, it is the habit of cultivating the friendship of fellow engineers. Third, it is the habit of standing up on one's feet before one's fellows to comment on papers under discussion; and fourth, it is the habit or taste for reading professional literaure not narrowly in one speciality, but broadly across the spectrum of engineering, economics, and political sciences.

STUDENT MEMBER DELEGATES AT THE REGION VII PACIFIC NORTHWEST STUDENT BRANCH CONFERENCE HELD AT WASHINGTON STATE COLLEGE, PULLMAN, WASH., AND UNIVERSITY OF IDAHO, MOSCOW, IDAHO, MAY 5–8, 1948

(Ten other conferences, at least one in each Region, were held in April and May, 1948. In the western Regions where engineering schools are widely scattered two conferences were held.)

1948 ASME Regional Student Conference Prize Winners

REGION I, UNIVERSITY OF MAINE, ORONO, MAINE, MAY 7–8, 1948

Attendance: 136 Papers Presented: 9

Prize	Recipient	Title of Paper	College
First	MATTHEW J. REISER	Scissors for Ten Cents	Northeastern University
Second	PETER ROGAN	Some Problems in the Investigation of the Thermal Conductivity of Soils	University of Connecticut
Third	ULRICH FRANK	The Relation Between Invention and Society	University of New Hampshire
Fourth	WILLIAM C. DAVIS	Measurements Using Interference of Light	Tufts College
Fifth and Old Guard	ROBERT A. HALL	A Five Dollar Hunting Rifle	University of Vermont

REGION II, COLLEGE OF THE CITY OF NEW YORK, NEW YORK, N. Y., MAY 1, 1948

Attendance: 160 Papers Presented: 11

Prize	Recipient	Title of Paper	College
First	SANFORD HALTER	Overdrive for Passenger Automobiles	Pratt Institute
Second	THOMAS SPARKS	Precision Cams	Poly. Inst. of Brooklyn (Eve.)
Third	JOSEPH SELIBER	Pilot Chamber Fuel Injection in Diesel Engines	College of the City of N. Y.
Fourth	EDWARD T. ROACH	Thermal Condenser Testing Apparatus	Poly. Inst. of Brooklyn (Day)
Old Guard	JOSEPH GRIMALDI	Some Considerations of Special Jet Engines	Columbia University

REGION III, LEHIGH UNIVERSITY, BETHLEHEM, PA., APRIL 16–17, 1948

Attendance: 220 Papers Presented: 16

Prize	Recipient	Title of Paper	College
First	FREDERICK GREEN, JR.	The Technique of Sending Free Balloons Into the Stratosphere	Swarthmore College
Second	ENOCH PERKINS	Elementary Principles of the Ramjet Engines	Lehigh University
Third	ELMER G. SUNDAY	Underground Gasification	George Washington University
Fourth and Old Guard	FRANK JACKSON	Vibration of Uniformly Twisted Bars	University of Pennsylvania
Fifth	HOWARD KALTBAUM	The Application of Steam Turbines to Locomotives	Cornell University

REGION IV, UNIVERSITY OF FLORIDA, SAVANNAH, GA., APRIL 5–6, 1948

Attendance: 175 Papers Presented: 10

Prize	Recipient	Title of Paper	College
First	BERTRAM W. ALLEN	Profits From Industrial Wastes	University of Florida
Second	HOWARD R. WINN	Moving Buildings	University of Tennessee
Third	BERNARD ROSS	Rotating-Piston Internal-Combustion Engine	Vanderbilt University
Fourth	ARCHIE W. FUTRELL	Controlled Weather	North Carolina State College
Fifth and Old Guard	GORDON H. LEWIS	Engineering Education—Past, Present, and Future	Georgia Institute of Technology

REGION V, MICHIGAN STATE COLLEGE, EAST LANSING, MICH., APRIL 26–27, 1948

Attendance: 125 Papers Presented: 5

Prize	Recipient	Title of Paper	College
First	THOMAS L. FAUL	Color Photography	University of Toronto
Second and Third (Tied)	WILLIAM H. KIRWAN AND DONALD BLACK	Fork Truck and Pallet for Material Handling	Case Institute of Technology
		What's Wrong With Our Engineering Education?	University of Detroit
Fourth	ROBERT L. DURWARD	The Chrone-Lab	Michigan State College
Fifth	CHARLES A. DALLY	History of Metalworking	Carnegie Institute of Technology

REGION VI, NORTHERN TIER, UNIVERSITY OF WISCONSIN, MADISON, WIS., MAY 10–11, 1948

Attendance: 95 Papers Presented: 10

Prize	Recipient	Title of Paper	College
First	WILLIAM B. ROBISON	Arc Welding Applied to the Manufacture of a Vise	Iowa State College
Second	EDWARD B. DAVIES	The Heat Pump	Illinois Institute of Tech.
Third	DARREL B. SEARLS	The Man Who Falls Forward	South Dakota State College
Fourth	FLORIAN JENDRICK	Opportunities for Mechanical Engineers in the Air-Frame Industry	North Dakota State College
Fifth and Old Guard	DONALD J. LAURIE	The Relationship of Invention and Engineering	University of Minnesota

REGION VI, SOUTHERN TIER, UNIVERSITY OF IOWA, DAVENPORT, IOWA, APRIL 19–20, 1948

Attendance: 173 Papers Presented: 8

Prize	Recipient	Title of Paper	College
First	DON E. COOLEY	Quick Freezing	Purdue University
Second	KEN COWDERY	Btu Utilization	University of Missouri
Third	CARY R. CREAMER	Sales Engineering	University of Louisville
Fourth and Old Guard	CARL L. SONNENSCHEIN	A Small Overfeed Stoker	University of Illinois
Fifth	C. ED. HARTZELL	It Blows Hot and Cold	University of Iowa

REGION VII, PACIFIC NORTHWEST, UNIVERSITY OF IDAHO AND WASHINGTON STATE COLLEGE, MOSCOW, IDAHO, AND PULLMAN, WASH., MAY 5–8, 1948

Attendance: 208 Papers Presented: 13

Prize	Recipient	Title of Paper	College
First	GEORGE FRANK	Gas-Turbine Development at OSC	Oregon State College
Second	JIM MACNICHOLS	The Possible Use of Ceramics for Gas-Turbine Parts	University of Washington
Third	HUGH M. ROWE	Problems Facing the Young Engineer	University of Utah
Fourth	ROGER D. OLLEMAN	Trends in Engineering Education	University of Washington
Fifth and Old Guard	DONALD E. WINTERS	Are State Driving Laws Adequate?	Montana State College

REGION VII, PACIFIC SOUTHWEST, CALIFORNIA INSTITUTE OF TECHNOLOGY, PASADENA, CALIF., APRIL 23–24, 1948.

Attendance: 95 Papers Presented: 9

Prize	Recipient	Title of Paper	College
First	WILLIAM SEIDEN	The Theory of Plastic Strain Propagation	California Institute of Technology
Second	GEORGE C. VANE	Hydraulic Model Studies of the Proposed Hunter's Point Breakwater	University of California
Third	JAMES T. MECKOLL	Cockpit Design or Lack of It as a Contributing Factor in Aircraft Accidents	University of Southern California
Fourth	M. TENNEY CAMPBELL	The Engineer—His Responsibility in Civic Affairs	University of Santa Clara
Fifth and Old Guard	NORMAN A. VOGEL	The Study of a Spontaneous-Ignition Engine	University of Santa Clara

REGION VIII, NORTHERN TIER, OKLAHOMA A&M COLLEGE, TULSA, OKLA., MAY 14–16, 1948

Attendance: 138 Papers Presented: 12

Prize	Recipient	Title of Paper	College
First	LEROY W. LEDGERWOOD	Hired Technicians or Professional Engineers	Oklahoma A&M College
Second	CHARLES H. GREEN	Stress Analysis of Steam Piping	University of Kansas
Third	JAMES JENSEN	Stability of Farm Tractors	University of Nebraska
Fourth	JOHN B. NORRIS	Antiaircraft Prediction Mechanisms	University of Arkansas
Fifth and Old Guard	REUBEN F. THOMAS	Repressuring of Oil Sands	University of Arkansas
Sixth	KEITH KETTLE	Process Engineering	University of Nebraska
Seventh	FRANK HAMLIN	The Use of Circular Orifices In Hot Water Heating Systems	Kansas State College
Honorable Mention	JACKSON HEDGECOCK	Elementary Selsyn Theory and Application	Kansas State College
	WILLIAM E. DAVIS	Softer Tires for Automobiles	Oklahoma A&M College
	WALTER M. SHARP	Advantages of Burning Liquefied Petroleum Gases in Spark Ignition Engines	University of Oklahoma
	JAMES T. MCKINNEY	Heat Pumps	University of Kansas
	RICHARD L. O'SHIELD	Psychrometric Charts	University of Oklahoma

REGION VIII, ROCKY MOUNTAIN, UNIVERSITY OF NEW MEXICO, ALBUQUERQUE, N. M., APRIL 23–24, 1948

Attendance: 117 Papers Presented: 11

Prize	Recipient	Title of Paper	College
First	DAVID M. LYON	A Method of High-Speed Photography	University of New Mexico
Second	MASON BARLOW, JR.	Testing and Adjusting of Air-Conditioning Systems	University of Wyoming
Third	JOHN SCHAUB	Metallurgy	New Mexico College of A&MA
Fourth	JACK D. LINEBERRY	Torque Conversion as Used in the Buick Dynaflow	University of New Mexico
Fifth	ED BROWN	Human Research in Supersonic Speed	New Mexico College of A&MA
Sixth and Old Guard	KENNETH C. REED	Application of Gas Turbine to Generation of Electrical Power	Colorado A&M College

Since habit is a growth phenomenon which takes hold slowly when a particular mode of action is repeated over a relatively long period of time, the ASME campus program encourages students early in the academic career to do the things engineers do in the way engineers do them.

The student-branch program of meetings is an extracurricular program. Attending meetings is sometimes a sacrifice on the part of a student. At most schools he gets no academic credit for this time any more than the engineer in industry gets paid for attending engineering meetings at night. Aside from the profit of listening to prominent mechanical engineers who may be visiting the student branch, the student will enjoy at branch meetings the fellowship of other members whom he would not have the opportunity of knowing through class or dormitory contact. Associations of these men will enrich his campus experience and plant the seeds of friendships which may blossom many years later in pleasant business encounters.

The student-branch program, because it is managed solely by students, poses responsibilities similar to those which will be faced in industrial and community life. By assuming responsibility for running a meeting, inviting speakers, entertaining visitors to the branch, preparing and discussing papers, and attending conferences, all in the framework of a campus activity, the student engineer grows professionally and will find no reluctance in facing the counterparts of these responsibilities which are so important to the life of the engineering profession.

Aid in creating proper professional habits is the intangible benefit of ASME student membership. It is not the only benefit. Every student member is entitled to his own copy of MECHANICAL ENGINEERING, and for his use the Society provides his student branch with monthly copies and the annual bound volume of Transactions.

Aid to Professional Thinking

The magazine with its broad editorial policy places the student in the mainstream of current professional thinking. Its availability encourages him, hard pressed as he is, to learn of the technical and professional problems which he may someday help to solve. The habit of reading and learning, day in and day out, so basic to a professional life, is one of the major ends of a professional education.

Students Pay Less Than Cost

Student membership costs the student only three dollars a year. This is one dollar less than the member subscription rate of MECHANICAL ENGINEERING for one year. The ASME spends more than $5000 annually to finance the annual student-branch conference, and several thousands more in administrative materials in excess of the amount received from student dues.

In spite of these recurring defects, members of the ASME, the majority of whom were student members in their day, support the student-branch program because of the personal conviction that the ASME, as a service organization for mechanical engineers, has a responsibility to the young men who are to follow them in the profession.

ASME Junior Forum

COMPILED AND EDITED BY A COMMITTEE OF JUNIOR MEMBERS, B. H. EDELSTEIN, CHAIRMAN

The Forum

THE Junior Forum is now starting its second season. It has weathered a slow start and is now ready for further expansion.

At a recent meeting of the Junior Committee attended by President Bailey, the purpose of the Forum was restated for clarification. It has been created to stimulate and develop junior participation in ASME activities and to facilitate the self-expression of the Juniors in their efforts to resolve the problems which confront them.

The Junior Forum Editorial Committee will endeavor to seek out and publish all material which will fulfill these two guiding concepts. To accomplish these ends your participation is earnestly requested.

To achieve full use of the Forum the following policy has been proposed:

1 The Junior Forum will publish within the space allocated all letters and comments, solicited and unsolicited, which are considered by the Junior Forum Editorial Committee to be of interest to the junior engineers and which do not violate professional ethics.

2 The Junior Forum shall endeavor to obtain its material directly from the junior membership rather than depend upon editorials from the members of the Editorial Committee.

3 The material solicited from the membership will include the following topics:

a Junior views upon special activities
b Book summaries
c Junior Group activities in all Sections
d Junior Group activities in other societies
e Other topics of Junior interest.

To implement its policy, the Forum will require the active participation of Juniors throughout the nation. Our Forum will succeed in reflecting the sentiments of the junior members only if each of us personally engages in some aspects of its publication. Here is the way in which this can be done.

Each region should form an advisory editorial committee to assist the Editorial Committee in the selection and preparation of material. If your regional vice-president has not contacted you yet, write to him that you are interested in forming and acting on such a committee. This will offer an interesting and enlightening way to work with your fellow engineer.

Reports of your activities and expressions of your ideas on any issue pertinent to the Junior Engineer will be welcomed. Just send them to the Editorial Committee. If you are hesitant in addressing your thoughts to the entire Society membership the Junior Forum assures you of an interested reception by your fellow Juniors.

Junior members who wish to join the Editorial Committee or who have any material to contribute are urged to write to B. H. Edelstein, 35-50 78th Street, Jackson Heights, N. Y.

What Makes for Success in Engineering

EARLY this year the Junior Section of The Engineering Society of Detroit with which the ASME Junior Group of the Detroit Section is affiliated, invited four engineers with broad experience in education and industry to speak on success in an engineering career and such problems of pay, security, and interest in job, which sometimes distress the young engineer seeking his place in the profession. Abstracts of the lectures have been prepared for the Forum by Allen E. Peters, secretary of the ESD Junior Section. Two of the lectures follow. The third and fourth will appear in the November Forum.

Specifications for Success

By O. W. Eshbach[1]

IN his opening remarks, Dean Eshbach recognized that any discussion concerned with success in any occupation is a very personalized one and most certainly could not be dealt with in general terms. A person's early life in a profession, too, is most challenging due to the fact that frequently there is a choice of directions or paths of advancement. Another problem presents itself where there is an opportunity for a young person to chose or transfer to an occupation which is a departure from his educational preparation.

This situation has been recognized by the Engineers' Council for Professional Development in an investigation and analysis of job success, personal qualities and attributes, and other related factors. A summary of this information is available in the form of "Suggestions to Junior Engineers" published by the Council.

Professional success is dependent upon certain personal characteristics:

1 Intelligence
2 High integrity
3 Social manner
4 Good educational background
5 Adherence to codes of ethics
6 Hard work and its related personal sacrifices.

Satisfaction of these criteria alone does not guarantee success but we must also consider:

1 The state of the profession
2 The need for the services the individual is prepared to render
3 The successful matching of capabilities with existent opportunities.

And then, if success is measured in individual happiness or personal satisfaction, the individual must live up to this achievement or "professional status." A professional man is one who possesses special knowledge and who has developed competence. This naturally leads to a very early consideration on the part of a young man—that of choosing a field in which to become specially learned and to develop proficiency.

The first criterion for the production of successful engineers is a system of selection. At present the engineering school is the agency for preparing young men for technological pursuits. Effective selection must take into consideration:

1 The engineering profession
2 The student
3 The parents
4 Society
5 American industry
6 An early opportunity to change.

The second criterion is the type of engineering schools we have. Such schools must develop competent professional engineers, able teachers, and highly qualified research workers. The curricula must reflect sound educational methods, and the vigorous faculty must stimulate students in their search for knowledge and truth.

The third criterion is the responsibility of employers (industry). The employer is the customer for the product of the school and in this position is entitled to be satisfied with the product. At the same time, industry must have consideration for the welfare and potentialities of the individual. There are always limitations on what the employer would like to do, and if he recognizes this and makes it known to the employee at the outset, much can be done toward a better frame of mind on the part of the employee.

Dean Eshbach then presented a series of slides which showed the present situation in so far as the growth of engineering is concerned, the normal needs of industry, the trends in employment of engineers, the difference in educational background of the professional engineering groups, the salary changes that have occurred and exist at present, and the educational situation and its impact upon the immediate future.

To summarize:

[1] Dean, Technological Institute, Northwestern University, Evanston, Ill.

Who's Queer?

IF you can't get along with a few people it may be their fault. If you can't get along with many, it's always your own fault.[2]

[2] New Proverbs for Young Engineers, by Philip W. Swain, editor, *Power*, McGraw-Hill Publishing Company, Inc., New York, N. Y. Mem. ASME.

1 Within the next four years there will be more engineering graduates than will be needed by American industry.
2 The minimum normal demand should not be less than 5 per cent of the total now employed in the field, which with actuarial facts being taken into consideration, and the fact that many graduates do not take employment in the profession, should be 20,000.
3 Industry is not apparently conscious of need for advanced education but the needs of the future point to its desirability.

Is There Elbow Room In Engineering?

By Maynard M. Boring[3]

MR. Boring opened his discussion with a number of facts which were certainly impressive to the group in attendance in terms of his eligibility to talk on the subject, "Is There Elbow Room in Engineering?" During his association with General Electric, he has interviewed approximately 125,000 college seniors on campuses throughout the United States. Of this number he has hired 15,000 of which two have become vice-presidents of the Company and one has become the president of an affiliated company.

It is generally recognized that there exists a high degree of unrest and uncertainty in schools. It is not uncommon to hear that "a young man cannot advance in industry today." But people who accept this statement evidently don't take into consideration that there is constant turnover in industry, that older men are "taken care of in an interesting way," and that men move in generations about every five years.

There should be many new horizons for development as a result of the impact of the development of atomic energy. Electronics is another tool (not a separate profession) that all fields of engineering can use. Mr. Boring also pointed out that radar will not present the possibilities that were predicted at the end of the war. There are many new developments and materials now appearing rapidly which of course present technical opportunity.

In 1948 the situation will exist that the supply of technically trained and educated men will meet or pass the demand. At this time we are riding a temporary peak in terms of employment opportunities, but within the next few years this situation will normalize and everyone will find his place. This will cause the veterans to learn a few lessons. It has not happened yet nor will it that a young man can start where his father left off.

The surplus of engineers which is bound to appear within the next several years will force them into many fields in which they can make valuable contributions. There is a place for an engineer in a tiny rural community. There is a trend toward the approaching of human problems on a factual engineering basis. There is a need for ingenious mechanical designers and there is a need for engineers in gadgeteering which until now has been left to the non-technical man.

Mr. Boring emphasized the fact that all too many young men are hitching their wagons to a star and overlooking immediate opportunities. A good reference for everyone to read is the pamphlet written recently by Paul Boynton of Socony-Vacuum Oil Company, entitled, "So You Want a Better Job."

There are four important phases in the life of a well-rounded man: his job; his home; his play; his faith. The play relates to his association with people, his cultural development and pursuits, his interest and participation in the community, and his sports and hobbies. The term "faith" not only relates to his religious faith but his outlook on life, his belief in our country, and his loyalty and integrity. A man who is not well rounded in these four ways can get along but he will be like the three-legged horse, he will get along but not very well.

There is adequate room for each one of us if we develop in every way. Of course we will bump our elbows along the way (depressions, etc.) but they should not knock us down.

"Is There Elbow Room in Engineering?" Yes, unlimited for those men who know what to do with opportunity in filling in old jobs and pioneering new things. A man is bound to be successful if he is willing to tackle any problem no matter how difficult it appears and if he is willing to help the other fellow along the way.

[3] Staff Assistant to vice-president in charge of engineering, General Electric Company, Schenectady, N. Y. Mem. ASME.

First Principle

PICK the right wife and learn how to get along with her.[2]

Which Job for the Graduating Engineer?

THIS question was vividly brought out at the recent annual meeting of the ASME Central Illinois Section. When the writer was faced with the same problem thirteen years ago, conditions were entirely different. At that time the question was "Is there a job?" Today, the senior student may sit back and, with a certain amount of smugness, pick and choose to his heart's desire. Employers are invading every campus and the situation is such that in almost every school the graduating engineer is assured of his position before he graduates. This in itself is indicative of the healthy "state of the Union."

At this meeting were present the president of the ASME, E. G. Bailey, many local industrial executives, section members, and student members from the University of Illinois and Bradley University. Following President Bailey's address "The Engineer's Opportunity," an open forum was held on the topic, limited in the main to questions by the students and answers by the speaker. It was during this discussion that it became evident that the chief problem of the graduating engineer was the decision to be made based on "which job," "for whom," "for how much?" Perhaps these few words will prove of assistance to the many who are faced with the same problems.

The Neophyte Engineer

I would compare the graduating engineer to a seedling, let us say, of a fruit tree. Here is a living object upon which lavish attention has been placed. The seed (the student) was implanted in favorable conditions of soil, climate, and fertilizer (the university), from which at the end of its allotted time and with much tilling, fertilizing, and protection from the elements (the process of education) there emerged a seedling (the graduating student) ready for transplanting, but not in a condition to provide a harvest for a number of years. Hereafter the same processes of culture (education) must be continued, in order that in time the ultimate goal will be reached and the seedling, now a tree (the experienced engineer), will bear fruit (experience, knowledge, ability, position) worthy and equal to or in excess of the time, effort, and expense incurred during the growing years.

It is upon this ultimate harvest that the attention should be paid at the beginning. This means that each step should be carefully taken, so that in the end the harvest may return the fruits of labor and continue throughout the years.

Which Job?

All things being equal, the first job is not the most important one, in the writer's opinion. Only in a few solitary cases does a man realize in which branch and type of work he will be most happy and successful. Therefore almost any job in engineering is a good one. I will not attempt here to enumerate the different and various types of mechanical engineering or the jobs within the industrial and business structures. Suffice it to say they are numerous and varied, many even defying cataloging.

The first job should not be too narrow in scope, generally speaking. The work performed by the personnel structure within which a man projects himself should not only be of such a nature as to afford him further education in his chosen path, but it should also present the opportunity to gather further knowledge in related fields of work. For example, the neophyte may take employment with a large engineering firm or with a plant engineering department in which many phases of mechanical, structural, electrical, architectural, and chemical engineering are performed. Suppose, for example, he first works at power-plant drafting. Here is a definite plan to follow. Let him perfect himself in his craft (drafting), never losing sight of the fact that drafting is the language of engineering. Let him know and be able to perform his job with engineering neatness, dispatch, and thoroughness. After the newness of his job has worn off and he is acclimated to it he will find it possible (and extremely advantageous) to look around and find out what the other branches and departments are doing and how they are doing it. The time approaches rapidly when he begins to realize whether or not his first job choice

was a good one, and from this realization he will be able to build his own plans for the future. It is conceivable that almost any man could go through this stage, and come out of it much the wiser.

So let me say that most any engineering job will do for a "first," the only qualification being that it will provide a broad scope and viewpoint for the engineer starting off on his first job.

Which Firm?

Here is one of the most important points to be analyzed before accepting a position with a company. There are many ways in which the prospective employee may decide this point for himself. The prospective employee should have the following information about a company before he goes to work for it:

1 The financial record, showing earnings, dividends, rate of activity, stockholders' reports, all of which can be had from the company itself, from a stockbroker, or a bank.

2 The employer-employee relations program—from the employer's representative and workers in the same plant.

3 The rate of advancement in both pay and position—from the company and workers.

4 The acceptance of the company's product—from salesmen, wholesalers, retailers, and consumers.

With these facts one should easily be able to judge for himself the desirability of working for a particular concern.

Wages?

Perhaps the least important of all, this is most frequently given the top consideration. In the first job, at least, there is much more to gain than mere dollars and cents. Further knowledge, experience, opportunity, contacts, and privilege of starting a career freely, are all worth more than can be appraised in terms of wages. Here let me admit that there are cases where this is not so; however, this is not the average today.

Some employers pay their junior engineers on an hourly basis, some weekly, some semimonthly, or monthly. In general, the hourly rate is the least desirable, if only for the following reason: Engineering is a profession and work output cannot usually be measured by any simple standard. The junior engineer may have the hourly rate to contend with, but he should bear in mind that this changes rapidly as experience increases.

Work?

There are many degrees of work, but I am interested in only one: An honest day's work. Most of us are familiar enough with the simplest form of business to realize that cost plus profit equals the selling price. Immediately we have a problem: The wages an employer pays to his employees is the employer's cost. Conversely, the wages an employee receives is the selling price of his labors. That just seems to muddle everything up a bit more. But let us forget the employer a moment and concentrate on the engineer. To be able to continue to advance up the ladder he must work and do so to his employer's gain. When a man has reached a point where he is known and spoken of with respect by both his colleagues and employer, you may be sure he gives full value in return for his wages, and when a man does that he is progressing and building for his future life and security. The knowledge one has of his own abilities will determine the amount of security one possesses.

The practicing engineer should not feel that his work ends when he takes his hat off the hook. That goes for all of us. There are many engineering periodicals which should be closely scanned; civic groups are badly in need of trained personnel; and the young man may profit by the resolve to spend a small amount of time pursuing some subject about which he would know more.

In summary: Let the man work, work as honestly as he can, at any engineering job he thinks he will be happy in, with any firm he feels sure will provide him with the potential outlets he needs, and then let him go on to learn and do justice to himself and his community.

H. FREDERICK LANGE.[4]

[4] Sales Engineer, Wilkins Pipe and Supply Company, Peoria, Ill.

Freedom

IF your abilities are not appreciated, don't sulk; get another job. This is a free country.[2]

ASME Sections

Coming Meetings

Boston: October 28. Northeastern University at 8:00 p.m. Subject: Production Possibilities With Tailor-Made Automatic Machinery, by Robert G. Dexter, firm of Barkley and Dexter, Boston, Mass.

Cincinnati: October 7. Engineering Societies Building at 8:00 p.m. Subject: Basic Factors and Trends in Modern Steam Power Plant Design, by Gustav A. Gaffert, vice-president, Sargent and Lundy Company, Chicago, Ill. Film: Power by Which We Live.

Ontario: October 14. Hart House, University of Toronto at 8:00 p.m. Subject: Discussion and Display of Instruments. Speaker to be announced. (Taylor Instrument Company, Toronto, Ontario, Can.)

Philadelphia: October 19. Engineering Building, University of Pennsylvania. Subject: Experimental Piping Stress Analysis, by J. D. Conrad, Westinghouse Electric Corporation, Lester, Pa.

October 26. Engineers' Club at 8:00 p.m. Subject: Design of The Sunbury Power Plant, by George Keenan, chief engineer, Pennsylvania Power and Light Company, Allentown, Pa.

Schenectady: October 21. American Locomotive Company. Inspection trip. Speaker to be announced.

Wilmington: October 20. Hob Tea Room at 6:00 p.m. Subject: Design Materials of Construction in Modern Factory Buildings Speaker to be announced.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., which is under the joint management of the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to members and is operated on a co-operative nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrants whose notices are placed in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available to members of the co-operating societies at a subscription of $3.50 per quarter or $12 per annum, payable in advance.

New York	Chicago	Detroit	San Francisco
8 West 40th St.	84 East Randolph Street	100 Farnsworth Ave.	57 Post Street

MEN AVAILABLE[1]

GRADUATE MECHANICAL ENGINEER, 28, single, seven and a half years' practice. Experience: Mill engineering in pulp and paper, project and development in metal manufacturing, equipment design and installation in smelter. Presently assistant engineer. Desires work with U. S. firm in South America. Me-333.

MECHANICAL ENGINEER, BSME, 35, experienced supervision design and construction steam power plants, hydroplants, and pumping plants. Can effect good personnel relationships. Location preferred, Southwest or West, except coast. Me-334.

[1] All men listed hold some form of ASME membership.

(*ASME News continued on page 862*)

CHECK

BOILER WATER LEVELS *at* EYE LEVEL

Boiler water level readings are brought right down to eye level—on the instrument panel or any other place in the power plant—with the Yarway Remote Liquid Level Indicator.

Indication is *instant* and *accurate* because indicator is operated by the boiler water itself. Mechanism is never under pressure. There are no stuffing boxes—operation is frictionless. Complete separation of indicating and actuating parts is obtained by permanent magner transmission.

Yarway Remote Indicators are used not only for boiler water level readings, but also for other liquid levels.

FOR COMPLETE DESCRIPTION WRITE FOR BULLETIN WG-1822

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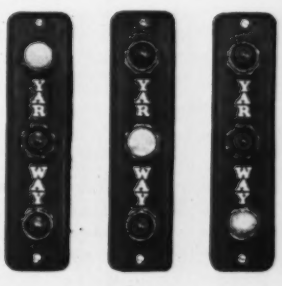
YARNALL-WARING COMPANY
108 Mermaid Avenue
Philadelphia 18, Pa.

NEW CONTROL UNIT PROVIDES REMOTE SIGNALLING

Yarway Indicator, when equipped with new Control Unit, operates additional horn or light alarm signals anywhere in the power plant. Control Unit may also be used as control for mechanical equipment.

Horn alarms



Light alarms

YARWAY REMOTE LIQUID LEVEL INDICATOR

MECHANICAL ENGINEER, 26, BSME, 2 years as Diesel engineer, U. S. Navy; 2 years of general construction and plant engineering; 1 year design. Desires permanent position with a future; preferably in the fields of air conditioning, machine design, or research. Will consider teaching while working for MS degree. Location preferred, St. Louis, Midwest, or Calif. Me-335.

MECHANICAL ENGINEER, 28, married. Experience: 6 years in machine shop, 2 years teaching engineering. Diesel training. Taking graduate work in mechanics, I.I.T. Prefers teaching position. Location, New York or Washington, D. C. Me-336.

CHIEF INDUSTRIAL ENGINEER, executive caliber. Graduate mechanical engineer. 10 years' experience in time study, methods, incentives, cost controls, budgetary controls, accounting, material handling, administrative work. Now head of department in major corporation. Location preferred, Chicago. Me-337-R-4831-C.

MECHANICAL AND ELECTRICAL ENGINEER, 36; British university honors degree, 11 years' experience; emigrating from India early 1949; at present company director in charge design, development, business, and administrative sides of medium-scale machinery manufacture. Desires allied or other suitable work in U.S.A. Me-338.

JUNIOR MECHANICAL ENGINEER, experienced instructor in engineering mechanics, expediter in aircraft construction, and technical liaison officer in Army ordnance developments with some patent experience, desires eastern location. Me-339.

MECHANICAL ENGINEER, licensed in Virginia, BS 1940; 7 years' experience design, development, and production problems on small precision mechanisms. Some travel acceptable. Accustomed to meeting people. Me-340.

MECHANICAL ENGINEER, BSME 1945; married, age 22. 2 years of machine and tool design. Ex-naval engineering officer. Desires sales or responsible machine or tool-design position. Anywhere within U.S.A. Me-341.

MARKETING ENGINEER, age 34, mechanical-engineering and business-administration degrees, with experience to analyze markets, establish best method of distribution, evaluate, and lead sales organization, train salesmen, plan special product promotion. Me-342.

MECHANICAL ENGINEER, 27, BSME. $2^1/_2$ years' experience supervising preparation of manufacturing drawings and writing of manufacturing specifications. 2 years' shop experience as a machinist. Desires production management position. Prefer Northeast U.S.A. Me-343.

MECHANICAL ENGINEER, graduate, June, 1948, Lafayette, 25, single. Desires trainee position in development engineering. Location preferred, northern New Jersey or New York area. Me-344.

POSITIONS AVAILABLE

INDUSTRIAL ENGINEER, 35–40, mechanical graduate, with at least 5 years' experience in time-study and wage-incentive work in iron and steel industry, to supervise time study, production control, wage incentive, standards, methods, and other phases of industrial-engineering division. $8000–$10,000. East. Y-967.

INSTRUCTOR, to teach mechanical heat power laboratory and to do research in this field at $3600 a year with one month's vacation. Location, Florida. Y-1359(a).

ASSISTANT TO PLANT ENGINEER, mechanical graduate, 28–45. Will be required to supervise the operation of the boiler room including maintenance. Will survey existing steam lines in the plant and maintain them, as well as recommend improvements. Will also assist the plant engineer with organizational and administrative work and the handling of other special maintenance assignments. Must be resident of northern New Jersey area. $4200–$4800. Y-1361.

TECHNICAL EDITOR, mechanical graduate, 30–40, with 5 to 10 years' experience covering design and application of metal products, machines, and equipment, to write articles covering new methods, applications, design modifications, etc. Salary, $6000–$7000. New York, N. Y. Y-1365.

ENGINEER, 40–45, graduate mechanical, mining, metallurgical, or industrial engineer with experience in heavy industry, and preferably familiar with the metallurgical field. Should have 10 to 15 years' experience in the design and engineering of heavy manufacturing industries and preferably some experience in plant operations. Should have ability to make factual and analytical determinations, to reason from them in forms to convince others. $8000. Headquarters, New York, N. Y. Y-1373.

INDUSTRIAL ENGINEER, 40–50, with considerable layout, methods, and general industrial experience for consulting firm. Occasional traveling. $6500–$7280. New York, N. Y. Y-1384.

MACHINE DESIGNER with 10 to 12 years' experience. Should have administrative ability and very strong mechanical-design ability. Position is primarily one of machine design on the drawing board, but will carry the opportunity for advancement to an administrative position in the future. Salary open. Northern New Jersey. Y-1384.

INDUSTRIAL ENGINEER, 25–35, with considerable experience in time study and methods and wage incentives covering needles trades. $4680–$6500. South. Y-1387.

INDUSTRIAL MANAGEMENT ENGINEER, 35–45, engineering graduate, with progressive industrial-engineering experience, including at least 5 years as chief industrial engineer of a large manufacturing organization for staff position with management-engineering firm. $8000–$10,000. Headquarters, New York, N. Y. Y-1400.

PROJECT SUPERVISOR, mechanical or chemical graduate, preferably with 15 to 20 years' experience in the layout and design of chemical manufacturing plants. At least 10 years of this experience should have been in responsible charge of major projects. Experience with plants for organic chemicals desirable, although some by-product coke-oven or refinery experience acceptable. Eastern seaboard Y-1404.

INDUSTRIAL ENGINEER, 35–40, graduate mechanical engineer who has had at least 10 years' experience in industrial engineering covering methods, materials handling, plant layout, machine efficiency, and machine design. Salary open. Considerable traveling. Headquarters, Pacific Northwest. Y-1408.

OFFICE ENGINEER, 30–40, mechanical graduate, with at least 5 years' experience, including graduate cadet engineering training with manufacturer, design, application, and estimating all types of air conditioning, refrigeration, and heating systems, to analyze the requirements for specific installations and prepare estimates, plans and specifications, and quotation contracts. $4200–$6000. New York, N. Y., with occasional foreign trips. Y-1411.

POWERHOUSE SUPERVISOR, under 55, with at least 10 years' supervisory experience in charge of power plant, to plan and supervise industrial steam power-plant operations including repairs of pumps, piping, and other mechanical devices, cleaning of stoker-fired boilers, records of personnel, cost of operation, including steam charts, and water consumption. Must know feedwater and boiler-water treatment and refrigeration operation for air-conditioning a large office. $4200–$5400. Six-day week, nights and week ends if necessary. Central New York State. Y-1412.

MECHANICAL DRAFTSMAN with experience, to lay out and detail prefabricated panels and connections for portable houses. $3900–$4420 New York, N. Y. Y-1418.

JUNIOR MECHANICAL ENGINEER with heating experience, to test direct-fired heaters and attend to specifications and contracts. $2700–$3000. Westchester County, N. Y. Y-1421.

SALES ENGINEER, mechanical graduate, with process and power-equipment experience, to represent manufacturer of controls, valves, strainers, etc. $3600. New York metropolitan area. Y-1433.

MECHANICAL DRAFTSMAN with experience on plumbing and heating on building construction. Salary, $120 a week for a 54-hour week; deduction of $10.50 for subsistence and quarters. One-year contract. Newfoundland. Y-1442.

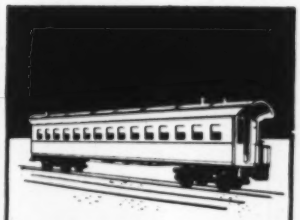
MECHANICAL ENGINEER, graduate, with experience in manufacture, design, and operation of automatic feeds and jigs for stamping and assembling small brass parts. Mass production. Permanent. Salary open. Newark, N. J. Y-1449.

TECHNICAL WRITER, 30–40, graduate mechanical engineer, with four to six years' industrial experience or teaching; two years time spent on full or part-time writing or editorial work on engineering reports, articles, or subjects. Duties are writing, revising, and editing instruction pamphlets and lesson texts used for correspondence instruction. Salary open. East. Y-1451.

DEAN OF SCHOOLS OF TECHNOLOGY, 35–45, civil, mechanical, electrical, or industrial graduate, with 5 to 10 years' engineering, supervisory, or teaching experience. Aptitude for technical writing, arranging curricula, and doing administrative work for correspondence school. Salary open. East. Y-1452.

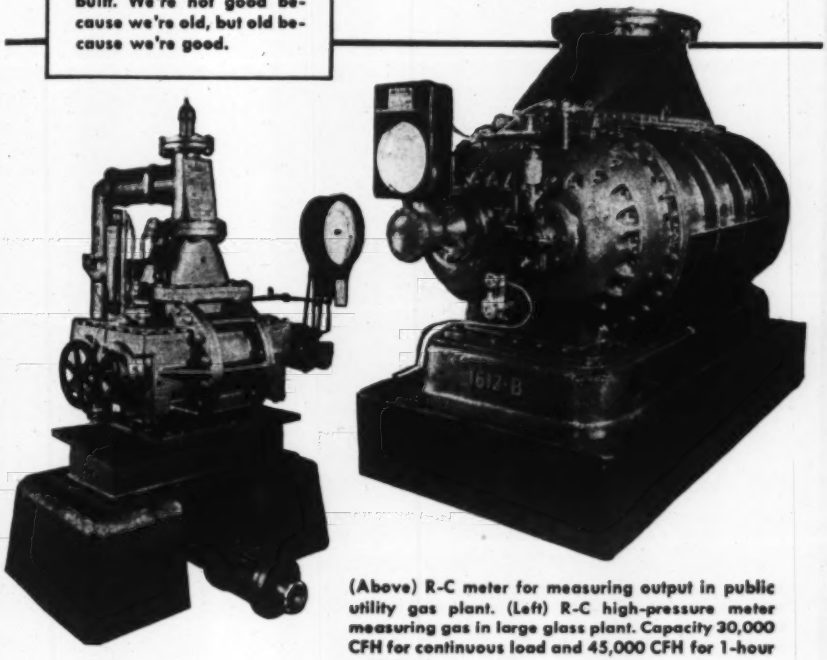
SALES ENGINEER, 30–35, mechanical graduate, with pump and machinery sales and service experience, to call on oil and chemical industries covering sale of packing and lubricated specialities. Must have car and reside near Philadelphia. $4800. Territories, eastern Pennsylvania, Delaware, and eastern Maryland. Y-1480.

(ASME News continued on page 864)



George M. Pullman's first sleeping car went into service in 1859, five years after the first Roots Blower was built. We're not good because we're old, but old because we're good.

Measure INPUT OR OUTPUT WITH CASH REGISTER *Accuracy*



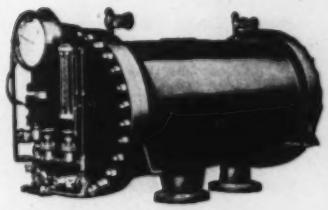
(Above) R-C meter for measuring output in public utility gas plant. (Left) R-C high-pressure meter measuring gas in large glass plant. Capacity 30,000 CFH for continuous load and 45,000 CFH for 1-hour peak load.

WIDE VARIETY OF R-C METERS FOR INDUSTRIAL USES

R-C Meters are available in 31 standard sizes, for maximum working pressures of 25 lbs., 50 lbs. and 125 lbs., and for capacities from 4,000 to 1,000,000 C F H. Meters for higher pressures or other unusual requirements can be adapted from standard units or built to the user's needs.

(Left) This 2½" x 7" meter has an inclined differential gauge, with top inlet, and outlet in bedplate.

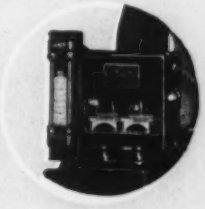
(Right) Large size low-pressure meter, with side inlet box, bottom outlet and P.V.T.T. Recorder.



(Above) Special high-pressure meter, for line pressures of 300 lbs. and up.

ACCESSORIES FOR R-C METERS

Many types of recorders and integrators are available for R-C Meters. They enable users to compile records for practically every phase of metering operations, for almost any unit of time.



R-C Meter equipped with pressure and temperature integrator which corrects for both pressure and temperature.

Wherever gas needs to be measured . . . for buying, selling or processing . . . you get unfailing accuracy from R-C Positive Displacement Meters. The reasons are:

1. Accuracy is not affected by variations in specific gravity, rate of flow, pulsation, moisture or impurities.
2. Accuracy does not depend on uncontrollable factors.
3. Accuracy is not subject to adjustment of meter or recorder by operators.
4. Accuracy is not affected by reasonable overloads.
5. Accuracy is permanent because measuring chambers are surrounded by precision-machined, cast-iron surfaces.

The wide use of R-C Meters by public utilities, producers, industrial users and processors is the best evidence of satisfactory performance. For details, ask for Bulletin 40-B-14 or write us about your specific problem.

ROOTS-CONNERSVILLE BLOWER CORPORATION
810 Michigan Avenue, Connersville, Indiana

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